Forest Research Information Paper No. **147**

Ontario Forest Research Institute Publications 1996 - 2000:

A Bibliography with Abstracts

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Deriving an Eco-regional Framework for Ontario
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Harvesting boreal mixedwood stands to favour conifer regeneration:

Ontario

Ontario Forest Research Institute
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A Bibliography with Abstracts

by

Lisa J. Buse

2001

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Abstract

Buse, L.J. 2001. Ontario Forest Research Institute Publications 1996-2000: A Bibliography with Abstracts. Ontario Ministry of Natural Resources, Ontario Forest Research Institute, Sault Ste. Marie, Ontario, Forest Research Information Paper No. 147. 105 p.

All publications written, co-authored, or commissioned by OFRI staff between 1996 and 2000 were compiled and annotated to produce this bibliography. During this period almost 500 publications were produced including 131 journal articles, 61 reports, 3 field guides/books, 21 technical notes, 52 newsletter/newsletter articles, 93 papers/summaries in conference/workshop proceedings, and 115 abstracts in conference/workshop proceedings. Author and subject indexes are provided.

Acknowledgements

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Introduction

This annotated bibliography includes journal articles, research reports, information papers, technical notes, newsletter articles, papers in conference proceedings, and brochures written, co-authored, or commissioned by OFRI staff between 1996 and 2000. Many of these publications report results of projects initially funded under Ontario's Sustainable Forestry Initiative.

Relative to the 6-year period reported in our previous bibliography (Gillmeister et al. 1996), more publications were produced between 1996 and 2000 (Table 1). Most significantly from a science perspective, the number of refereed journal articles published each year has almost doubled. The number of journal articles is particularly high in 1997 as a result of 2 special issues—*New Forests* published papers from an IUFRO stock quality conference hosted by OFRI in 1994 and *The Forestry Chronicle* published papers from a 1996 Canadian Institute of Forestry/OMNR conference focussed on the Fallingsnow Ecosystem Project. Although the number of abstracts in conference proceedings are shown in the summary table, they are not included in the bibliography to reduce duplication since most projects have since been published in journals. The increase in conference summaries in 1998 is because OFRI hosted the Third International Forest Vegetation Management Conference.

Publications are listed alphabetically by first author chronologically. Authors names are in brackets if not from OFRI at time publication (developed). Only OFRI authors are included in the author index (Appendix I). A subject index is also provided (Appendix II) in addition to listings of report series by number — Forest Research Reports (Appendix III), Forest Research Information Papers (Appendix IV), Forest Research Notes (Appendix V), Science Development and Transfer Series (Appendix VI), and Forest Landscape Ecology Program reports (Appendix VII).

Appendix VIII provides contact information for ordering publications not available from OFRI as noted in individual abstracts.

Table 1. Summary of number and type of publications produced by OFRI authors between 1996 and 2000.

Publication	1996	1997	1998	1999	2000
Reports	22	16	11	7	5
Technical notes	10	5	2	1	3
Newsletter/ Newsletter or magazine article	20	8	11	5	8
Paper/summary in Conference/ Workshop Proceeding	13	2	60	6	12
Abstract in Conference/ Workshop Proceeding*	52	16	9	16	22
Book chapter	–	–	–	1	6
Book/Field guide	1	1	–	–	1
Journal article	13	43	24	26	25
CD-ROM software tool	2	–	2	–	–
Other (Internal report/brochure)	3	–	3	–	4
Total	136	91	122	62	86

*Not included in bibliography

Publications 1996

Anderson, H.W. and J.A. Rice. 1996.
Quality assurance in hardwood tree marking: A case study.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 141. 14 p.
(An intensive audit implemented by OMNR in Algonquin Provincial Park in 1986, to monitor the quality of tree marking operations in 87 hardwood stands, indicated that a maximum allowable error expressed as relative number of tree-choice and/or basal area errors is a realistic quality standard. The need for continuous monitoring to track performance and to allow revision is discussed. Suggestions for efficient sampling design and data collection methods are outlined.)

Bankowski, J., D. Dey, (E. Boysen), (M. Woods) and J. Rice. 1996.
Validation of NE-TWIGS for tolerant hardwood stands in Ontario.
Ont. Min. Nat. Res., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 130. 21 p.
(This paper reports tests of NE-TWIGS, an individual-tree, distance-independant stand growth simulator, for Ontario's tolerant hardwood stands. It indicates that although stand productivity data may improve its performance, NE-TWIGS does not reliably predict basal area, particularly for medium and large sawlogs, in Ontario's hardwood stands.)

Bell, F.W., (M.S. McLaughlan) and L.J. Buse. 1996.
Vegetation management techniques for mixedwoods.
Pp. 134-137 *in* Advancing Boreal Mixedwood Management in Ontario Workshop Proc. C.R. Smith and G.W. Crook , comp. Sault Ste. Marie, ON, 17-19 Oct. 1996. Can. For. Serv., Ont. Min. Nat. Resour., Sault Ste. Marie, ON.
(Most vegetation management techniques used for conifers, such as animal grazing, motor-manual and mechanical cutting, and ground application of herbicides, can be modified for use in mixedwoods.)

(Bruhn, J.N.), (J.D. Mihail) and T.R. Meyer. 1996.
Using spatial and temporal patterns of Armillaria root disease to formulate management recommendations for Ontario's black spruce (*Picea mariana*) seed orchards.
Can. J. For. Res. 26: 298-305.
(Between 1982 and 1989, 22 black spruce seed orchards were established on cleared jack pine forest land in northwest Ontario. These orchards were located on sites stressful for black spruce to hasten seed production. Mortality caused by *Armillaria ostoyae* (Romagn.) Herink was observed in most of these orchards within 3 years of establishment. This study was initiated to quantitatively describe the temporal progress and spatial patterns of Armillaria root disease mortality in 5 representative orchards, to determine future operational management implications. In the 4 orchards where epidemics developed, temporal disease progress was nonlinear and was better described by the monomolecular function than by the Gompertz or logistic functions. Monomolecular rates of disease increase were 0.0062-0.0346. Applying these rates, we estimated that cumulative Armillaria root disease mortality will be 9 to 41% and 25 to 79%, at 20 and 50 years after planting, respectively. Armillaria root disease mortality was spatially aggregated in all 4 orchards. Trees adjacent to Armillaria-killed trees had an increased probability of mortality from Armillaria root disease. Successive epidemics may develop in these orchards; their timing and severity will be affected by orchard management practices. Measures of spruce family performance in these orchards are compromised by the aggregated distributions of different *A. ostoyae* genets and the root disease they cause.)

Buchert, G.P. 1996.
Genetic diversity – An indicator of sustainability.
Pp. 190-193 *in* Advancing Boreal Mixedwood Management in Ontario; Workshop Proc. C.R. Smith and G.W. Crook, comp. Sault Ste. Marie, ON, 17-19 Oct. 1995. Can. For. Serv., Ont. Min. Nat. Resour.

(This summary describes how genetic diversity differences between intact and affected gene pools in the boreal forest provide a yardstick to determine whether or not the adaptive and long-term evolutionary potential of tree populations has been compromised by forestry practices.)

Buse, L.J. 1996.
Northwest Region: Controlling spruce budworm defoliation in seed orchards.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 1(2): 6-7.
(This article reviews the use of Azadirachtin, a botanical insecticide, in the control of spruce budworm in Ontario seed orchards as an environmentally sound alternative to chemical insecticides.)

Buse, L.J., (A. Morneault) and F.W. Bell. 1996.
Research in the regions: Season and height of cutting dictate effectiveness.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 2(1): 4-5.
(Results of a study established in 1993-94 indicate that aspen should be cut as close to the root as possible if the stand is to be managed as a mixedwood. This promotes root suckering of aspen and encourages quality stems. If the objective is to minimize aspen regrowth, cutting should occur in mid-summer above 50 cm but below the first live branch.)

Buse, L.J. and F.W. Bell . 1996.
Northeast Region: Sheep grazing affects site vegetation.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 1(2): 6.
(This article looks at the use of sheep as an alternative vegetation management tool and the danger of importing non-native vegetation via use of out-of-area feed.)

Buse, L.J., (J. Mackenzie) and V. Zakrzewski. 1996.
Research in the regions: Growth and yield modelling toolkit being developed.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. Insights 2(1): 7-8.
(This article provides an overview of 2 timber cruising data acquisition programs being developed under the umbrella of the growth and yield modelling framework.)

(Cumming, H.G.), R.A. Lautenschlager, (C.P. Kelly) and (S. Thapa.) 1996.
Effects of conifer release with Vision (glyphosate) herbicide on moose forage quality (digestible protein).
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 139. 8 p.
(Digestible protein percentages in 4 important moose foods (aspen, willow, hazel, raspberry) were not significantly reduced either 4 or 8 years after treatment with Vision herbicide. Protein in summer leaves was higher than winter twigs. Trembling aspen produced higher levels of protein than the other 3 species examined. Long-term predictions of the effects of Vision herbicide on moose forage should be based on forage quantity.)

(de Groot, P.), E. Schnekenburger, (R.A. Fleming) and (J.J. Turgeon). 1996.
User's guide to ConeSys: A cone crop monitoring and insect pest management decision support system for seed orchards.
Nat. Resour. Can.-Can. For. Serv./Ont. Min. Nat. Resour., NODA/NFP Tech. Rep. No. TR-24. Binder and diskette.
(ConeSys is a computer-based system to assist seed orchard managers in collecting data on the quality and quantity of cones and seeds from their orchard, and assist them in making informed decisions about insect pest management. This publication describes the general features and functions of ConeSys and provides step-by-step instructions on how to use the program in the field and laboratory. *(Order from Canadian Forest Service - Great Lakes Forestry Centre.)*)

Dey, D.C., M.T. Ter-Mikaelian, (P.S. Johnson) and (S.R. Shifley). 1996.

User's Guide to ACORn: A Comprehensive Ozark Regeneration Simulator.

U.S.D.A. For. Ser., North Cent. For. Exp. Stn., Gen. Tech. Rep. No. NC-180. 35 p.

(ACORn is a computer program that can help forest managers predict the number of species of trees that will regenerate following harvest in upland oak stands in the Ozark Highlands of Missouri and adjacent States including the oaks, hickories, blackgum, sassafras, and flowering dogwood. ACORn predicts the expected height or diameter distributions of major trees species at 5, 10, and 21 years after complete overstory removal. ACORn also predicts stocking values by species and diameter class at age 21. The models used in ACORn are based on more than 20 years of data from research plots in the region. *(Order from USDA For. Ser.)*)

Dey, D.C., (P.S. Johnson) and (H.E. Garrett). 1996.

Modeling the regeneration of oak stands in the Missouri Ozark Highlands.

Can. J. For. Res. 26(4): 573-583.

(An approach based on (1) a growth model that is applicable to both oak sprouts and advance regeneration, and (2) a method for estimating future size distributions of trees, is used to predict the early development of upland oak stands in the Ozark Highlands of southern Missouri.)

Dey, D.C. and (R.P. Guyette). 1996.

Early fire history near Papineau Lake, Ontario.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Note No. 54. 4 p.

(Site specific fire histories that document fire frequency, fire behaviour, fire effects on forest regeneration and growth, and the influence of human activities, are being developed in upland red oak-pine ecosystems in central Ontario by the Great Lakes-St. Lawrence silviculture program. This report presents the fire history from 1634 to 1875 of an oak-pine stand near Papineau Lake, Ontario. Fire scars in old white pine stumps were used to develop the fire chronology.)

Dey, D.C. and (R.P. Guyette). 1996.

Early fire history near Seguin Falls, Ontario.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Note No. 55. 4 p.

(This report is one of a series of site-specific fire histories developed for red oak-pine ecosystems in central Ontario. Collectively, these studies document the role of fire in upland oak forests and provide an ecological basis for developing silvicultural prescriptions that use prescribed burning to promote oak regeneration and maintain or restore fire-dependent forests by emulating natural disturbance processes. By dating fire scars on cross-sections cut from old white pine stumps, a fire chronology was developed, using sampling and dendrochronological methods, for an oak-mixed hardwood-pine site for the period 1656 to 1861. Man-caused fires (aboriginal travel routes and village sites, as well as historical First Nations vs. fur trader conflicts) were probably largely responsible for the variability in fire frequency during this period.)

Dey, D.C. and (R.P. Guyette). 1996.

Fire history near an historic travel corridor in Ontario.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 140. 9 p.

(Fire scars from stumps of white pine in a mixed hardwood forest near North Bay, Ontario were dated using dendrochronological methods. A ring-width chronology was crossdated within the site and subsequently dated in absolute time with a nearby white pine chronology derived from old living white pine near Hobbs Lake. A composite fire scar chronology was constructed for the period 1721 to 1937 for an area less than 0.5 km^2 near the Jocko and Ottawa rivers. The period between any 2 successive fires ranged from 4 to 29 years. The mean fire-free interval was 14 years for the the period 1721 - 1920. The stable fire regime of

frequent fires at this site is associated with its proximity to historic travel corridors and trade routes. An increase in radial growth of white pine, which lasted for up to 13 years, was observed following many of the low intensity surface fires at the Jocko site.)

Dey, D.C. and W.C. Parker. 1996.
Regeneration of red oak (*Quercus rubra* L.) using shelterwood systems: Ecophysiology, silviculture, and management recommendations.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 126. 59 p.
(This paper reviews the ecology, physiology, and reproductive biology of red oak. The importance of seedling ecophysiology and regeneration ecology is vital to the use and further development of the shelterwood method for regenerating red oak.)

Forest Landscape Ecology Program. 1996.
Surficial geology of Ontario: Digital database and viewing software .
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. CD-ROM.
(A digital atlas of Ontario's surficial geology. Background information and user's guide published as Perera et al. 1996 FLEP Rep. 22.)

Forest Landscape Ecology Program. 1996.
Surficial geology of Ontario: Digital database, viewing software, and GIS data.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. CD-ROM.
(A digital atlas of Ontario's surficial geology that includes GIS data. Background information and user's guide published as Perera et al. 1996 FLEP Rep. 22.)

Gillmeister, D. 1996.
Central Region: Assessing plantation ecology.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. Insights 1(2): 7-8.
(This article discusses how an ongoing project undertaken by the Ontario Forest Research Institute incorporates the most modern technology available into current plantation management techniques in order to devise efficient methods of timber production that are also easy on the environment.)

Gillmeister, D.L., L.J. Buse and D. Bates. 1996.
Ontario Forest Research Institute publications 1990-1995: An annotated bibliography.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 125. 85 p.
(This annotated bibliography covers published research reports, journal articles, technical notes, papers and abstracts in conference proceedings, and newsletter articles written or co-authored by staff of the Ontario Forest Research Institute (OFRI) between 1990 and 1995.)

(Gluck, M.), (R. Rempel) and P.W.C. Uhlig. 1996.
An evaluation of remote sensing for regional wetland mapping applications.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 137. 33 p.
(The objectives of this study were to (1) evaluate techniques for characterizing wetland components using remote sensing and GIS technologies, and (2) assess the effectiveness of these techniques to produce a wetland map for a northwestern Ontario landscape. Three techniques (colour infrared photography at 3 scales, digital classification of Landsat TM satellite imagery, and Forest Resource Inventory digital data) were evaluated to determine the minimum technology required to classify and map wetland classes within specified levels of accuracy.)

Greifenhagen, S., G. Halicki Hayden and J. Saunders. 1996.
Regeneration pest management: 1995 annual report.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., 26 p.
(This annual report summarizes the work

accomplished by the Regeneration Pest Management Program in 1995, including research results and updates, and data from pest surveys.)

Hak, O. 1996.
Vacuum processing and storage of spruce pollen.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 136. 6 p.
(Effectiveness and efficiency of vacuum processing for pollen storage were studied in black and white spruce. Vacuum processing is recommended for storage because pollen viability can be maintained during shipment and in long-term storage when temperature control may fail or not be possible.)

(Harris, A.G.), S.C. McMurray, P.W.C. Uhlig, (J.K. Jeglum), (R.F. Foster) and (G.D. Racey). 1996.
Field guide to the wetland ecosystem classification for northwestern Ontario.
Ont. Min. Nat. Resour., Northwest Sci. Technol., NWST Field Guide No. FG-01. 74 p. + append.
(This guide provides a framework for classifying wetlands in northwestern Ontario using vegetation and environmental features. It includes keys, fact sheets, ordinations and environmental data summaries for 36 wetland community types. It is complementary to the northwestern Ontario Forest Ecosystem Classification, which describes forested communities. *(Purchase from Lakehead University Bookstore.)*

Hayden, J., (M. Woods), (E. Boysen), (J. Mackenzie), (W. Lewis), (B. Richard), Z. Brodzik, J. Matuszyk and R. Miller. 1996.
Ontario Forest Growth and Yield Program 1995-1996 annual report.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. 17 p.
(The primary objective of Ontario's Forest Growth and Yield Program is to provide data, information, and knowledge that will advance sustainable resource management planning. This annual report provides an overview of the provincial and regional components of the program, information about work completed to date and ongoing projects.)

(Hayes, A.E.) and W.G. Cole. (eds.). 1996.
Long-term Ecological Research Program: 1995 annual report.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. For. Res. Inf. Pap. No. 135. 26 p.
(The Long-Term Ecological Research Program examines Ontario's forest ecosystems to contribute to the advancement of the Ontario Ministry of Natural Resources' goal of sustainable resource and ecosystem management. This report describes the objectives of the program and summarizes 1995 research results and technology transfer activities.)

Ho, R.H. 1996.
Promotion of cone production on field-grown grafts of eastern white pine by gibberellin A4/7 injection.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 138. 6 p.
(Six- and 11-year-old eastern white pine grafts growing in a breeding orchard were stem-injected once every 2 weeks with gibberellin A4/7 for a total of 4 times in each of 3 periods. The results of 2 consecutive studies indicate that best pollen- and seed-cone production are achieved with gibberellin treatments in May and June, during the period of rapid lateral shoot elongation.)

Ho, R.H., O. Hak, (M.H. Laine) and (R.D. Ford). 1996.
Promotion of pollen-cone production by heat treatment and naphthalene acetic acid spraying in potted black spruce.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 135. 12 p.
(Naphthaleneacetic acid (NAA) was sprayed at various concentrations onto black spruce grafts that were growing in a heated greenhouse or in an outdoor holding area. Whole trees were sprayed weekly for 5 weeks in each of 2 periods; the first period began from bud burst to the end of rapid

lateral shoot elongation and the second from the middle of rapid lateral shoot elongation to primordia initiation on the shoot apices. Spraying was ineffective for promoting pollen- and seed-cone production. Heat treatment alone appeared to promote the production of pollen and seed cones; combining NAA sprays had no additional effect. Graft mortality increased with increasing NAA concentrations.)

(Jayaraman, K.) and W.T. Zakrzewski. 1996.

Regression with autocorrelated errors: Application in stem-profile models.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Note No. 53. 8 p.
(This statistical note describes a practical approach to handling the problem of correlated errors when calibrating linear and nonlinear models. The approach is not model specific and can be applied to models that need to be calibrated in the presence of correlated errors.)

(Johnson, E.), J. Paterson, (G. Leeder), (C. Mansfield), (F. Pinto) and (S. Watson). 1996.

Artificial regeneration of Ontario's forests: Species and stock selection manual.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 131. 49 p. + append.
(This species and stock selection manual presents an overview of the operational procedures involved in Ontario's artificial regeneration program and covers 6 main topics: seed considerations, types of nursery stock, selecting nursery stock, ordering seedlings, handling and care of planting stock, and monitoring seedling health.)

(Kennedy, J.), (E.M. Harvey) and W.C. Parker. 1996.

Natural regeneration of Ontario's major commercial coniferous species: A bibliography.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 134. 106 p.
(This bibliography collects more than 500 citations for reports published over the last 60 years addressing operational, silvicultural, and ecological aspects of the natural regeneration of Ontario's major commercial coniferous species: balsam fir, white spruce, black spruce, jack pine, red pine, white pine.)

(Korzukhin, M.D.), M.T. Ter-Mikaelian and R.G. Wagner. 1996.

Process versus empirical models: Which approach for forest ecosystem management?

Can. J. For. Res. 26(5): 879-887.
(Empirical models describe the statistical relationships among data with little regard for the structure, rules, or behaviour of an object. In contrast, process models describe data using key mechanisms or processes that determine internal structure, rules, and behaviour. Based on these differences the authors argue that process models are more likely to meet the challenges presented by ecosystem-based forest management.)

Lautenschlager, R.A. 1996.

Identify the specifics: A biopolitical approach for establishing research priorities.

J. For. 94(4): 31-34.
(This article outlines a proposal for biologically based, politically adjusted research priorities in Ontario.)

Lautenschlager, R.A. 1996.

Predictive adaptive management - applying natural resource management research.

Pp. 148-151 *in* Advancing Boreal Mixedwood Management in Ontario; Workshop Proc. C.R. Smith and G.W. Crook, comp. Sault Ste. Marie, ON, 17-19 Oct. 1995. Can. For. Serv., Ont. Min. Nat. Resour., Sault Ste. Marie, ON.
(This summary proposes that to advance forest management in an ecosystem context, we must begin implementing larger-scale (at least watershed-level), operationally meaningful forest management research. Adaptive management offers that potential and with proper modifications (predictive adaptive management, or PAM), it could

incorporate social interests. The PAM approach: (1) includes appropriate publics in management decisions; (2) addresses local and regional concerns; (3) implements existing knowledge; (4) integrates research teams; and (5) implements ecosystem management even without complete knowledge.)

(Lewis, W.), R.J. Miller and (M.E. Woods). 1996.
Jack pine site index curves and tables for South Central and Northeast Regions.
Ont. Min. Nat. Resour., South Central Sci. Sect., Tech. Note No. 01. 8 p. + append.
(Ek's model and stem analysis data from dominant and codominant trees were used to develop jack pine site index curves for the Northeast and South Central Regions of Ontario. These will continue to be refined as new data become available.)

Li, C. and (M.J. Apps). 1996.
Effects of contagious disturbance on forest temporal dynamics.
Ecol. Model. 87:143-151.
(The effects of 2 types of stand replacing disturbances on the boreal forest are compared using a landscape model. The results suggest that more attention be paid to spatial dynamics affected by contagious disturbance processes when simulating the biomass dynamics of forests that are strongly influenced by disturbance regimes.)

Li, C., M.T. Ter-Mikaelian and A.H. Perera. 1996.
Ontario fire regime model: Its background, rationale, development, and use.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Landscape Ecol. Program: For. Fragment. Biodiv. Proj. Rep. No. 25. 42 p.
(This report describes a study of forest fire dynamics at the landscape scale. The objective was to develop a spatially explicit model that can simulate long-term fire dynamics in Ontario, especially in the boreal region. ON-FIRE (ONtario FIre REgime model) was developed for simulating fire regimes that result from the interaction between fire events and forest landscapes, as influenced by weather.)

(Liu, S.H.), (R.A. Campbell), (J.A. Studens) and R.G. Wagner. 1996.
Absorption and translocation of glyphosate in aspen (*Populus tremuloides* Michx.) as influenced by droplet size, droplet number, and herbicide concentration.
Weed Sci. 44:482-488.
(When herbicide concentration was constant, absorption of glyphosate increased with larger droplet size. The amount of glyphosate translocated away from the treated area, expressed as percent of absorbed, increased as droplet size decreased. Herbicide concentration of the droplet was more important than droplet number or size in determining absorption and translocation. Large droplets caused localized tissue injury, which may have caused decreased translocation.)

MacDonald, G.B. 1996.
The emergence of boreal mixedwood management in Ontario: Background and prospects.
Pp. 11-20 *in* Advancing Boreal Mixedwood Management in Ontario; Workshop Proc. C.R. Smith and G.W. Crook, comp. Sault Ste. Marie, ON, 17-19 Oct. 1995. Can. For. Serv., Ont. Min. Nat. Resour., Sault Ste. Marie, ON.
(This paper presents a site-based definition of the boreal mixedwood forest of Ontario, describes the rationale for intentional mixedwood management, traces the evolution of mixedwood management in the province, and outlines future prospects.)

MacDonald, G.B. 1996.
Mixedwood demonstration area and guided walking trail.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Bilingual flyer. 2 p.
(A mixedwood demonstration area is located in a mature mixedwood stand, north of Iroquois Falls, Ontario. A walking trail provides a self-guided tour of the area, and the opportunity to learn how mixedwood forests provide many benefits and discover how partial cutting affects the growth of understory trees and other vegetation. This flyer includes map and background information.)

MacDonald, G.B. 1996.
Mixedwood management research and practice in Ontario.
Pp. 102-113 *in* Silviculture of Temperate and Boreal Broadleaf-Conifer Mixtures. P.G. Comeau and K.D. Thomas, eds. Richmond, B.C., 28 Feb. - 1 Mar. 1995. B.C. Min. For.
(This paper describes Ontario's boreal mixedwood forest, discusses the advantages and current status of mixedwood management in Ontario, and presents some opportunities for management and research in the near future.)

(Mallik, A.U.), (G.W. Peterson) and F.W. Bell. 1996.
Vegetative seedling regeneration of pin cherry (*Prunus pensylvanica*): Efficacy of herbicide treatment.
Can. For. Serv., Great Lakes For. Cent., NODA Note No. 21. 4 p.
(The objectives of this study were to document seedling recruitment, seed production, and soil seed banking of pin cherry and evaluate the efficacy of Vision herbicide to control this competitor. Pin cherry regenerates primarily vegetatively. Vision controls vegetative reproduction but after herbicide treatment pin cherry will regenerate through seedlings.)

Matuszyk, J. 1996.
Ontario Forest Research Institute trial plot register.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Int. Rep. 31 p.
(A list of OFRI trial plots across the province was compiled to make districts and forest industry aware of research values on the areas they are managing. For each trial, location, species, year of establishment, area, project title, and contact person are provided.)

(McLaughlan, M.S.), (D. Myketa) and F.W. Bell. 1996.
Managing vegetation with herbicides: A review of glyphosate, 2,4-D, hexazinone, triclopyr, and simazine.
In F.W. Bell, M. McLaughlan and J. Kerley (comp.), Vegetation management alternatives - A guide to opportunities. Ont. Min. Nat. Resour., Northwest. Sci. Technol., NWST Tech. Note No. 37. 12 p.
(This note reviews the advantages and disadvantages of using herbicides for vegetation management, compares the uses of 5 common herbicides, and indicates the relative susceptibility of various weed species to each herbicide.)

(McLaughlan, M.S.), (R.E. Mickle) and F.W. Bell. 1996.
Aerial application of herbicides: A review of common aircraft and drift prediction tools.
In F.W. Bell, M. McLaughlan and J. Kerley (comp.), Vegetation management alternatives - A guide to opportunities. Ont. Min. Nat. Resour., Northwest. Sci. Technol., NWST Tech. Note No. 36. 8 p.
(This note provides an overview of the advantages and disadvantages of aerial herbicide application, and types of spray aircraft, and discusses some of the drift modelling tools currently available.)

Menes, P.A., K.D. Odlum and J.M. Paterson. 1996.
Comparative performance of bareroot and container-grown seedlings: An annotated bibliography.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 132. 151 p.
(This report annotates papers that provide performance comparisons of bareroot and container stock and represents the state of knowledge about seedling performance in North America.)

Obenchain, A.M. 1996.
Southern Region: Incorporating growth and yield data into a study of rare warblers.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 1(2): 7.
(This article describes how a Queen's University research project that examines the habitat requirements and nesting behaviour of the cerulean warbler has integrated data from Ontario's Growth and Yield Program – values such as tree growth, vegetation, soils, and wildlife habitat – into the study.)

Odlum, K.D. and (T.J. Blake). 1996.

A comparison of analytical approaches for assessing freezing damage in black spruce using electrolyte leakage methods.

Can. J. Bot. 74(6): 952-958.

(This study compared different methods of quantifying shoot frost damage during controlled plant freezing tests. Frost hardening of black spruce seedlings exposed to 3 temperature hardening regimes over 16 weeks was assessed using electrolyte leakage and intact seedling methods. Methods of quantifying plant hardiness were highly correlated.)

Papadopol, C.S. 1996.

Impacts of climate change on boreal mixedwood forests in Ontario and ways to mitigate them.

Pp. 101-105 *in* Advancing Boreal Mixedwood Management in Ontario; Workshop Proc. C.R. Smith and G.W. Crook, comp. Sault Ste. Marie, ON, 17-19 Oct. 1995. Can. For. Serv., Ont. Min. Nat. Resour., Sault Ste. Marie, ON.

(This paper describes the general negative influences of global climate change, with a focus on the belt of mixedwood forests in Ontario. A series of practical measures, aimed at mitigating the general effect of global climate change and adapting existing forest ecosystems to ensuing changes, are proposed.)

Parker, W.C. and F.W. Bell. 1996.

White pine response to bracken fern competition.

Ont. Min. Nat. Resour., Central Sci. Technol., OnLine No. Winter: 5-6.

(The objective of this study is to examine the effects of bracken fern competition on white pine regeneration. Preliminary results indicate that shading by bracken fern inhibits both photosynthesis and growth of white pine regeneration.)

Parker, W.C. and S.J. Colombo. 1996.

A comparison of the composite and repeat pressurization methods of pressure-volume analysis for shoots of four North American conifer species.

Plant Cell Environ. 19: 991-997.

(Significantly different water relations attributes were derived for temperate conifers using the composite and repeat pressurization pressure-volume procedures. Jack pine, red pine, and black spruce, but not white pine, had lower full turgor osmotic potential, shallower slope of the linear segment of the pressure-volume curve, and higher symplast fraction with the composite method.)

Parker, W.C. and S.J. Colombo. 1996.

Cut-shoot vs root rehydration: Effects on pressure-volume analysis of shoots and fascicles of *Pinus resinosa* seedlings.

Physiol. Plant. 97: 651-658.

(Two methods (cut-shoot and root rehydration) of rehydrating red pine shoots for pressure-volume (PV) analysis were compared to clarify the effects of rehydration on estimated tissue water relations of shoots and fascicles. Estimated apoplastic water fraction was higher for needle fascicles than shoots despite the large amount of woody stem tissue contained in shoots. Fascicle water status strongly influenced shoot water relations, in part due to apparent apoplastic loading with water of fascicles during rehydration.)

Perera, A.H., (J.A. Baker), (L.E. Band) and D.J.B. Baldwin. 1996.

A strategic framework to eco-regionalize Ontario.

Environ. Monitor. Assess. 39: 85-96.

(This paper describes a hierarchical eco-regional framework (HEF) constructed for Ontario. HEF is based on the scale-specific expression of ecological domain structure (geo-climatological parameters) and function (primary productivity). The approach relies on current advances in ecological hierarchy theory, and remote sensing, GIS, and statistical techniques.)

Perera, A.H. and R.E. Bae. 1996.

A multithematic spatial database for managing boreal mixedwood forests of Ontario.

Pp. 73-76 *in* Advancing Boreal Mixedwood Management in Ontario; Workshop Proc. C.R. Smith and G.W. Crook, comp. Sault Ste. Marie, ON, 17-19 Oct. 1995. Can. For. Serv., Ont. Min. Nat. Resour., Sault Ste. Marie, ON.

(This paper describes a comprehensive spatial database, assembled by the Forest Landscape Ecology Program, which is suited for managing boreal mixedwood forests in Ontario. Forest land cover, historical forest harvests, historical forest fires, surficial geology and substrate, topography, and climate are basic components of the database. These data permit the use of new tools such as geographic information systems for increased spatial accuracy in decision making.)

Perera, A., (J. Laguna), D. Baldwin, R. Bae, (H. Godschalk), M. Ouellette and (S. Pala). 1996.

Surficial geology of Ontario: A digital database.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Landscape Ecol. Program: For. Fragment. Biodiv. Proj. Rep. No. 22. 32 p. + append.

(This report describes the development and use of a surficial geology database that was assembled for landscape analyses in Ontario. This spatial database is self-contained in a CD-ROM with a customized data viewing and retrieval software package. It is unique because it: (1) integrates 4 original surficial geology map sources in Ontario into a common classification; (2) combines digital terrain data with the surficial geology theme; and (3) is available in digital GIS (geographic information system) format.)

(Sarker, R.), (D. McKenney), (B. Nippers) and D. Joyce. 1996.

SEEDCOST: The cost of seed for artificial regeneration in Ontario.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Genetic Resour. Manage., Gen. Tech. Rep. No. 2. 27 p.

(The cost of seed collection, processing, and storage is often overlooked when considering artificial regeneration options. A windows-based decision-support tool has been developed to help local managers record relevant information and track seed costs.)

(Strobl, S.) and R.G. Wagner. 1996.

Early results with translucent tree shelters in southern Ontario.

Pp. 13-18 *in* Proc. of the Tree Shelter Conference. Brissette, J. C., Ed. Harrisburg, PA, 20-22 June 1995. USDA For. Serv., Northeast. For. Exp. Stn.

(Growth and survival of red oak seedlings with several types of translucent tree shelters are being compared at 5 old-field sites in southern Ontario. Height of Tubex-sheltered red oak is still greater ($p=.0021$) than that for unsheltered trees after 5 years. The Quill shelter is not recommended; third-year red oak height was significantly smaller ($p=.0001$) than that for either a mesh shelter or no shelter. Survival was not different between sheltered and unsheltered seedlings. It is too early to determine whether tree shelters can reduce the need for vegetation control.)

(Sullivan, T.P.), R.A. Lautenschlager and R.G. Wagner. 1996.

Influence of glyphosate on vegetation dynamics in different successional stages of sub-boreal spruce forest.

Weed Technol. 10:439-446.

(This article reports on a study designed to evaluate changes in plant biomass, species richness, and diversity after application of glyphosate herbicide in several successional stages of sub-boreal spruce forest near Prince George, B.C. The general lack of community-wide reductions in plant biomass and diversity, and the short-term duration of specific changes, suggest that conifer release treatments of plantations have no substantial, incremental effects on wildlife habitat.)

Ter-Mikaelian, M.T. and (M.D. Korzukhin). 1996.
Biomass equations for North American tree species: A unifying approach.
Pp. 576-584 *in* Proc. IUFRO Conf. Modelling Regeneration Success and Early Growth of Forest Stands. J.P. Skovsgaard and V.K. Johannsen, eds. Copenhagen, Denmark, 10-13 June 1996.
(This paper examines the variety of biomass equations for North American tree species reported in the literature. It identifies that the various biomass equations for an individual species form a distinct pattern. The pattern occurred for all species studied except trembling aspen, and offers an explanation for this pattern.)

Ter-Mikaelian, M.T., R.G. Wagner, (C. Shropshire), F.W. Bell and (C.J. Swanton). 1996.
Model of PAR transmission through young forest plant canopies: Links with other models and implications for PAR measurements in plant competition studies.
Pp. 406-414 *in* Proc. IUFRO Conference Modelling Regeneration Success and Early Growth of Forest Stands. J.P. Skovsgaard and V.K. Johannsen, eds. Copenhagen, Denmark, 10-13 June 1996.
(This paper describes a study that developed an individual plant-based model to predict instantaneous photosynthetically active radiation (PAR) availability in young forest plant canopies. The model was calibrated using data from a 2-year-old plant density study. Results indicate that: (1) light sensor location is important; (2) plant arrangement is not; (3) instantaneous PAR is correlated with the daily average; and (4) PAR transmission is relatively stable throughout the entire daylight period.)

Uhlig, P.W.C. and (J.K. Jordan). 1996.
A spatial hierarchical framework for the co-management of ecosystems in Canada and the United States for the Upper Great Lakes Region.
Environ. Monitor. Assess. 39: 59-73.
(This paper outlines the range of ecosystem classification approaches that exist in the Upper Great Lakes region. Canadian and American hierarchical frameworks are briefly examined. Specific information needs and tasks are outlined which must be followed, independent of national boundaries, for the successful integration of planning and monitoring programs for large regional ecosystems. A general model is proposed for the development and application of an integrated, multi-scale and bi-national ecosystem classification, inventory and information system.)

Uhlig, P.W.C. and (R.A. Sims). 1996.
Boreal mixedwoods in Ontario: Defining the resource in relation to climate and soil/site.
Pp. 22-32 *in* Advancing Boreal Mixedwood Management in Ontario; Workshop Proc. C.R. Smith and G.W. Crook, Comp. Sault Ste. Marie, ON, 17-19 Oct. 1995. Can. For. Serv., Ont. Min. Nat. Resour., Sault Ste. Marie, ON.
(Based upon an evaluation of the network of forest ecosystem classification plots in northern Ontario, boreal mixedwoods are quantitatively described in terms of some associated climate and soil/site features. Results demonstrate that there are data and methodologies currently available to better describe the boreal mixedwood resource in Ontario – but we first need to better define that resource. Some recommendations to accomplish this are provided.)

Wagner, R.G. and (M.S. McLaughlan). 1996.
Forest vegetation management alternatives: A forward to the guide.
In F.W. Bell, M. McLaughlan and J. Kerley (Comp.), Vegetation Management Alternatives - A Guide to Opportunities. Ont. Min. Nat. Resour., Northwest. Sci. Technol., NWST Tech. Note No. TN-38. 8 p.
(This note provides an overview of vegetation management, potential alternatives to herbicides, and the contents of the guide to opportunities.)

Wagner, R.G., T.L. Noland and G.H. Mohammed. 1996.

Timing and duration of herbaceous vegetation control around four northern coniferous species.

N. Z. J. For. Sci. 26(1/2): 39-52.

(Optimum timing and duration of herbaceous vegetation control can be assessed using critical-period analysis. Critical periods are being developed for black spruce, jack pine, eastern white pine, and red pine seedlings in the Great Lakes-St. Lawrence forest type of Ontario, Canada. Six patterns of herbaceous vegetation control were examined: 3 consecutive years, first-year only, first 2 years, second and third years, third-year only, and no control. Third-year survival and height were not affected by herbaceous vegetation for any conifer species. Stem diameters for white pine, jack pine, black spruce, and red pine without vegetation control were 55, 56, 61, and 64%, respectively, of that observed for trees under 3 consecutive years of vegetation control. Stem volume of all species without vegetation control was reduced to between 27 and 36% of that observed under 3 consecutive years of control. Critical-period analysis indicated that herbaceous vegetation control is important immediately after planting for both tolerant and intolerant conifer species. Stem diameter gains were proportional to the number of years of herbaceous vegetation control.)

Wagner, R.G., T.L. Noland and G.H. Mohammed. 1996.

Timing and duration of herbaceous vegetation control around four northern coniferous species.

Pp. 138-140 *in* Advancing Boreal Mixedwood Management in Ontario; Workshop Proc. C.R. Smith and G.W. Crook, comp. Sault Ste. Marie, ON, 17-19 Oct. 1995. Can. For. Serv., Ont. Min. Nat. Resour., Sault Ste. Marie, ON.

(This paper describes how optimum timing and duration of herbaceous vegetation control during the early development of forest plantations can be assessed using critical period analysis. Critical periods are being developed for black spruce, jack pine, eastern white pine, and red pine seedlings. Critical period analysis indicates that herbaceous vegetation control is important immediately after planting for both tolerant and intolerant conifer species. Preliminary critical period models also indicate that stem diameter gains are proportional to the number of years of herbaceous vegetation control.)

Watt, J. 1996.

Anthropogenic fire: A new perspective on the fire/oak connection.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 1(2): 4-6.

(This article describes research that looks at the fire scars on tree stumps, documenting historic fire chronologies that can be correlated with the recorded history of native and early European movement/occupation in the area.)

Watt, J. 1996.

From forest to wasteland to forest.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 1(2): 1-4.

(This article discusses the successional history of southern Ontario's pine plantations; from the pre-settlement and its degeneration into virtual wasteland via over-logging and over-farming, to its reclamation through artificially regenerated plantations and its current status where research is finding ways to revert plantations to native forest.)

Watt, J. (ed.). 1996.

Insights.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. 2(1): 8 p.

(This issue of OFRI's newsletter highlights mixedwood management research.)

Watt, J. (ed.). 1996.

Insights.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. 1(2): 8 p.

(This issue of OFRI's newsletter highlights restoration work in southern Ontario and fire history research in central Ontario.)

Watt, J. 1996.
Managing Ontario's boreal mixedwood forest.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 2(1): 1-4.
(This article describes a boreal mixedwood demonstration area that is part of the Lake Abitibi Model Forest and showcases some of the recent mixedwood management research being undertaken by OFRI. The mechanisms by which research feeds into management guidelines are discussed.)

Watt, J. 1996.
OFRI scientist wins Amethyst.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 2(1): 6.
(The when and whys of Dr. Steve Colombo's Amethyst Award.)

Watt, J. 1996.
Research in the regions: Super trees, super fast.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 2(1): 5-6.
(This article describes the use of advanced generation breeding to improve the efficiency and economics of tree improvement efforts.)

Watt, J. 1996.
Tracking Ontario's trees.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 1(2): 1-2.
(This article describes the goals and methodology of a project shared by the Ontario Forest Research Institute and the Arboretum at the University of Guelph leading to the publication of an atlas. The atlas will be a catalogue of the populations of tree species in Ontario and where they are distributed.)

Watt, J. 1996.
We lived with the trees.
Ont. Min. Nat. Resour., ASKI Summer/Fall: 29.
(1995 marked 50 years of continuously funded forest research in Ontario. This article is a popular look at OFRI's half century of discovery.)

Weingartner, D.H. 1996.
Changing philosophies and management for boreal mixedwood.
Pp. 55-60 *in* Advancing Boreal Mixedwood Management in Ontario; Workshop Proc. C.R. Smith and G.W. Crook, comp. Sault Ste. Marie, ON, 17-19 Oct. 1995. Can. For. Serv., Ont. Min. Nat. Resour., Sault Ste. Marie, ON.
(This paper presents some issues, values, and ideas within the context of sustainability and ecosystem management that are influencing, and will influence, the development of forest management and silvicultural practice within the boreal mixedwood forest.)

(White, R.G.) and D. Joyce. 1996.
New seed zones for Ontario.
Ont. Min. Nat. Resour., Boreal Sci. Oshki OnLine Boreal Sci. Newsl. No. 1 (1): 15-16. (This article describes the development of new climate-based seed zones for Ontario.)

(Woods, M.E.) and R.J. Miller. 1996.
Red pine and white pine site index curves and tables for South Central Region.
Ont. Min. Nat. Resour., South Central Sci. Sect., Tech. Note No. 02. 11 p.
(This report presents red pine and white pine curves and yield tables specifically for the south and central areas of Ontario. The curves were derived from stem analysis data from dominant and codominant trees sampled in central Ontario.)

Publications 1997

(Beall, F.D.), (T.J. Blake), S.J. Colombo, (A. Darlington), (K. Vishnevetskaia) and (G.W. Crook). 1997.
Anti-stress antioxidant enhances growth and stress tolerance in conifer transplants.
Nat. Resour. Can., Can. For. Serv., Sault Ste. Marie, ON., NODA Note No. 31. 8 p.

(This research project was designed to consider the hypothesis that seed treatments with Ambiol increase stress tolerance. Seedlings grown from Ambiol-treated seeds were examined to determine changes in seedling morphology, and to note the response of gas exchange parameters to Ambiol treatment during the early stages of drought. The results of this project and subsequent work suggest that Ambiol treatment does indeed show promise as a seed conditioning treatment.)

Bell, F.W., (K.R. Ride), (M.L. St.-Amour) and (M. Ryans). 1997.
Productivity, cost, efficacy and cost effectiveness of motor-manual, mechanical, and herbicide release of boreal spruce plantations.
For. Chron. 73(1): 39-46.
(This study quantified the relative productivity, costs, treatment efficacy, and cost effectiveness of (1) motor-manual cutting (brush saws), (2) mechanical brush cutting (Silvana Selective/Ford Versatile), (3) helicopter application of Vision (a.i. glyphosate) herbicide, (4) helicopter application of Release (a.i. triclopyr) herbicide, and compared these to control (untreated) plots. Productivity was lowest for brush saws. Treatment and supervision costs were highest for Silvana Selective. Vegetation indices for herbaceous plants were lowest in Vision treated plots. The average cost-effectiveness ratio was lower for Vision, followed by Release, Silvana Selective, and highest for brush saws.)

Bell, F.W., (P.J. Bastarache) and (L.Meyer). 1997.
Jack pine fertilization: A review of the literature.
Ont. Min. Nat. Resour., Northwest Sci. Technol., Tech. Rep. No. 111. 18 p.
(Not all jack pine stands will respond to fertilization. Response is determined by a number of factors including soil properties, stand characteristics, type of fertilizer, method of application, and stand management. Jack pine fertilization experiments to date have been based on stand age. Most of the research occurred in mid- to late-rotation stands that were already at the self-thinning stage. Fertilization sped up the self-thinning process, but resulted in small gains in the gross volume of treated and untreated stands. Results from these trials suggest that nitrogen fertilizers should only be applied to stands growing at densities without forecast self-thinning (i.e., stands below the self-thinning line on a density management diagram). An illustration of a potential thinning and fertilizing scenario using a density management diagram for jack pine is provided.)

Bell, F.W., R.A. Lautenschlager, R.G. Wagner, (D.G. Pitt), (J.W. Hawkins) and (K.R. Ride). 1997.
Motor-manual, mechanical, and herbicide release affect early successional vegetation in northwestern Ontario.
For. Chron. 73(1): 61-68.
(Cover and height of vegetation before and 1 growing season after: (1) motor-manual cutting, (2) mechanical brush cutting (Silvana Selective/Ford Versatile), (3) aerial application of Release (a.i. triclopyr) herbicide, (4) aerial application of Vision (a.i. glyphosate) herbicide, and (5) control (no treatment) were quantified. Post-treatment cover of deciduous tree and shrub groups was lower in herbicide-treated plots than in cut plots. Forb, grass, and sedge cover varied greatly among treatments. Vision reduced woody and herbaceous vegetation most.)

(Binder, W.D.), (P. Fielder), G.H. Mohammed and (S.J. L'Hirondelle). 1997.
Applications of chlorophyll fluorescence for stock quality assessment with different types of fluorometers.
New For. 13(1-3): 63-89.
(We demonstrate some stress detection and stock quality applications of fluorescence to conifer seedlings using 3 types of fluorometers: an integrating fluorometer (IF) for laboratory use, and 2 field-portable pulse-modulated instruments, the

EARS-PPM (EARS) and PAM-2000 (PAM). Freezing tests showed that as temperature decreased, the IF and EARS detected decreased fluorescence in white spruce seedlings. F_v/F_m from the IF was highly correlated with quantum yield (op) from the EARS. The relationship between op and visible injury in white spruce was strongest when op was measured at low light levels. Freezing-stressed Sitka spruce seedlings also showed decreased op. Values of op in the dark were about 20% higher than in the light; but the ops were highly correlated. Heating Sitka spruce seedlings showed that op decreased linearly as duration at 40°C increased. Although there was some recovery in op after 5 days, it was a good indicator of subsequent growth. Desiccation tests showed that the PAM and IF both detected water stress in jack pine seedlings but the values for F_v/F_m differed. Moderate stress was detected by the PAM as higher q_c and lower op, and by the IF as delayed t_{M2}. For severe stress, the PAM detected lower F_v/F_M, q_p, Q_p, and op, and F_{M2} disappeared from IF curves. Gross photosynthesis (Gp), measured by the EARS, can be used as be a quick estimator of net photosynthesis, but its use as an estimator of seedling quality requires further study.)

(Boychuck, D.) and A.H. Perera. 1997.

Modelling temporal variability of boreal landscape age-classes under different fire disturbance regimes and spatial scales.

Can. J. For. Res. 27(7): 1083-1094. (An existing theoretical simulation model of landscape fire disturbance was used to explore the temporal variability of 2 selected landscape attributes: the percentages of old growth and recently disturbed area. Under characteristic boreal fire disturbance regimes, these percentages can vary widely over time, even at large spatial scales, due to the spatiotemporal autocorrelation of disturbances. Some of the implications of managing a landscape for naturalness at multiple spatial scales are discussed.)

(Boychuk, D.), A.H. Perera, M.T. Ter-Mikaelian, (D.L. Martell) and C. Li. 1997.

Modelling the effect of spatial scale and correlated fire disturbances on forest age distribution.

Ecol. Model. 95:145-164.

(We present insight into some of the fundamental factors that determine forest age distribution. We analyzed some alternative spatial models of fire disturbance, and used a spatial simulation model to explore whether forest age distribution has an exponential shape, and whether it would be stable or variable over time under different conditions. We found that, under characteristic boreal fire disturbance regimes, we should not expect to find forest age distribution stability even at very large spatial scales due to the spatial and temporal correlation of disturbances.)

(Brockerhoff, E.G.) and R.H. Ho. 1997.

Effects of gibberellin A4/7 stem injection on seed cone production in mature black spruce.

Can. J. For. Res. 27(8): 1325-1328.

(Two injections of 50 mg of gibberellin A4/7 into the trunk base of 27-year-old black spruce, during rapid vegetative shoot elongation, gave a fourfold significant increase of seed cone production in the following year compared with controls. A similar increase was reflected in the mean total weight per tree of nearly mature cones. Gibberellin A4/7 induced additional cone buds during a very heavy cone crop. Potential effects of gibberellin treatments on phytophagous insects are discussed.)

Buchert, G.P., (O.P. Rajora), J.V. Hood and (B.P. Dancik). 1997.

Effects of harvesting on genetic diversity in old-growth eastern white pine in Ontario, Canada.

Conserv. Biol. 11(3): 747-758.

(Genetic diversity at 54 isozyme loci coding for 16 enzymes in megagametophytes were compared between preharvest and postharvest gene pools of

2 adjacent virgin, old-growth (~250 years) stands of eastern white pine in the Galloway Lake old growth pine area of central Ontario. The concurrence of genetic diversity changes between the stands suggests that real and repeatable genetic erosion occurred in these gene pools as a result of harvesting. The total and mean number of alleles detected in each stand were reduced by approximately 25% after tree density reductions of 75%. The percentage of polymorphic loci dropped by about 33% from preharvest levels. About 40% of the low frequency alleles and 80% of the rare alleles were lost from each stand because of harvesting. Latent genetic potential of each stand was reduced by about 50% suggesting that the ability of these gene pools to adapt to changing environmental conditions may have been compromised. Heterozygosity estimates in the postharvest stands did not reflect reductions in allelic richness due to harvesting. Observed heterozygosity increased by 12% in one stand after harvesting, even though other genetic diversity measures decreased. Gene frequency changes due to harvesting imply that gene pools of naturally regenerated progeny stands may be quite different from the original parental stands. Silvicultural practices should ensure that the gene pools of remaining old-growth stands have been reconstituted in the regenerating stands.)

(Candau, J.-N.), (R.A. Fleming), (A.A. Hopkin) and A.H. Perera. 1997.

Characterizing spruce budworm-caused disturbance regimes in Ontario.

Pp. 132-139 *in* Disturbance in Boreal Forest Ecosystems: Human Impacts and Natural Processes. S.G. Conard, ed. Duluth, MN, 4-7 Aug 1997. USDA For. Serv., North Central Res. Sta., Gen. Tech. Rep. NC-209.

(This research represents a first step towards developing an understanding of natural disturbance dynamics and patterns for spruce budworm populations in Ontario. The spruce budworm's disturbance regime is described and analyzed to reveal the underlying dynamic processes. These characteristics will then be used to develop a model framework.)

(Chourmouzis, C.), (C. Hollstedt), F.W. Bell, (D. Myketa) and (A.M. Gordon). 1997.

Effect of Vision on seed germination of red raspberry from the soil seed bank.

Ont. Min. Nat. Resour., Northwest Sci. Technol., Tech. Rep. No. 107. 8 p.

(This study examines the effect of Vision (a.i. glyphosate) silvicultural herbicide on the soil seed bank of red raspberry. Two rates of Vision (1.1 and 1.7 kg a.i./ha) were applied on 5 dates (July 21, July 31, August 15, August 28, September 25) to a young jack pine plantation in northwestern Ontario in 1990. Soil samples, collected in the fall of 1991, were potted and monitored for red raspberry seed germination under greenhouse conditions for a period of 4 months. Germination of red raspberry was not significantly affected by Vision and there was no significant interaction between rate and time of herbicide application.)

Cole, W. and A. Obenchain. 1997.

Research on lake shorelines in Algonquin Park reveals ancient logs and diverse habitat: 1000-year-old logs.

Wildflower Summer:16-19.

(New research from central Ontario shows that the complex tangle of logs in the shallow water along a shoreline provides rare and unique habitat for an ecosystem that is incredibly rich in both plant and animal life. Researchers discovered these ancient logs during a series of studies focusing on the forest-lake ecotone in 2 lakes in Ontario's Algonquin Provincial Park. Several parts of the forest-lake ecotone are critical to sustaining brook trout in central Ontario lakes. Research questions that have emerged during this project include whether forestry or cottage building activities along shorelines affect the quantity or quality of ground water that flows into the shoals via springs, and how critical the types and quantity of shoreline woody vegetation are to the young trout in the spring, and to the soil microorganisms on which they feed.)

Colombo, S.J. 1997.

Frost hardening spruce container stock for overwintering in Ontario.

New For. 13(1-3): 449-467.

(In Ontario, a database of frost hardiness, bud initiation, and needle primordia development, covering over 200 stock lots, provides a valuable source of information for refining container stock hardening. The database shows large differences in approaches to hardening regimes and identifies factors needing additional research that were reflected in levels of freezing damage, winter desiccation, and overwintering success. Frost hardening rates of crops produced in north central Ontario failed to show significant seed source effects.)

(Cormier, D.) and J. Paterson. 1997.

A comparison of five site-preparation methods in central Ontario.

For. Engin. Res. Inst. Silv. Note, No. TN-264. 8 p.

(FERIC compared 5 site-preparation methods in central Ontario. The study was designed to measure equipment productivity, assess the results in terms of microsite quality, and calculate the costs of the various operations. This report describes the equipment used, its economics, and its effectiveness in creating acceptable planting sites.)

(Davis, C.N.) and T.R. Meyer. 1997.

Field Guide to Tree Diseases of Ontario.

Can. For. Serv., Great Lakes For. Cent., NODA/NFP Tech. Rep. No. 46. 135 p.

(This pocket-sized guide is intended for use in the field to identify tree diseases, to recognize and understand disease effects, and to provide recommendations for appropriate forest tree disease management actions for approximately 150 diseases. *(Order from CFS.)*)

Dey, D.C. and W.C. Parker. 1997.

Overstory density affects field performance of underplanted red oak (*Quercus rubra* L.) in Ontario.

N. J. Appl. For. 14(3): 120-125.

(Red oak seedlings were underplanted in a closed-canopy mature northern hardwood stand and an adjacent shelterwood in central Ontario. After 2 years, seedling survival was 90% in the uncut stand and over 99% in the shelterwood. Seedlings in the shelterwood were about 2 mm larger in diameter and nearly twice as tall as those in the uncut stand. Second-year stem diameter and height distribution of planted oak were significantly different in the shelterwood and the uncut stand. Loss of vigour, growth declines, and increased mortality of planted oak were largely a result of extremely low understory light levels in the uncut stand. Results of this study suggest that red oak underplanted in an uncut stand 2 or more years before a shelterwood harvest will be at a competitive disadvantage once they are released. Establishment and performance of underplanted red oak is promoted by shelterwoods that provide adequate light at the forest floor.)

Dey, D.C. and W.C. Parker. 1997.

Morphological indicators of stock quality and field performance of red oak (*Quercus rubra L.*) seedlings underplanted in a central Ontario shelterwood.

New For. 14:145-156.

(The value of initial diameter near the root collar, shoot length, and number of first-order lateral roots (FOLR) as morphological indicators of stock quality and field performance was examined for bareroot red oak underplanted in a shelterwood in central Ontario. Initial diameter, shoot length, and number of FOLR were positively and significantly correlated with second year height and diameter. Of the 3 indicators, diameter was also the best predictor of several physical characteristics of root systems 2 years after planting. Stem diameter 2 years after planting was more strongly related to root volume, area, and dry mass than was initial diameter, the probable result of adjustment in root-shoot balance of planting stock to the shelterwood environment.)

(Fogal, W.), (T.C. Hutchinson) and (A.M. Thriscutt). 1997.
Bioindicators of forest health and sustainability - Review report and project implementation strategies.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 138. 88 p. + append.
(The Ontario Ministry of Natural Resources (OMNR) has undertaken an examination of the role that remote sensing applications can play in assessing forest health and sustainability. The primary objective of this project is to conduct a formal review and evaluation of the use of remote sensing applications to assess forest health and sustainability. The report reviews and evaluates practical applications in Canada and abroad, identifies actual applications, reviews passive and active systems of spectral analysis, describes technologies in terms of biological relevance, identifies the most sensitive and appropriate indicator species. The report also outlines a design framework for forest health monitoring, and suggests some general implementation strategies for consideration.)

(Gregory, R.), (J. Flynn), (S.M. Johnson), (T.A. Satterfield), (P. Slovic) and R.G. Wagner. 1997.
Decision-pathway surveys: A tool for resource managers.
Land Econ. 73(2): 240-254.
(This paper introduces an experimental "decision-pathways" survey technique that builds on insights from behavioural decision theory. The approach presents respondents with a set of linked questions that encourage the deliberate construction of expressed values in the course of selecting a preferred resource-management alternative. By selecting one pathway and avoiding others, important information is revealed about respondents' key trade-offs and about their reasoning processes. A general discussion of the approach is followed by the results of a 1994 survey in Ontario, Canada, of public support for a range of forest vegetation management alternatives.)

Greifenhagen, S. and G. Halicki-Hayden. 1997.
Assessing conifer seed for fungal pathogens.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Note No. 56. 8 p.
(Seed assays can be a useful tool in an integrated nursery pest management program. Seedlots with potential germination and early disease problems (e.g., damping-off, shoot blights) can be identified prior to sowing the crop. Preventative strategies can be put in place to reduce possible disease losses. These preventative strategies include seed cleaning and cultural strategies.)

(Gurd, D.B.) 1997.
Effects of timber management on wildlife: Conceptual and analytical issues.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Landscape Ecol. Program, For. Fragment. Biodiv. Proj. Rep. No. 24. 33 p.
(Timber management should strive to maintain the variation in habitat quantity and quality produced by the natural dynamics of forested landscapes. This will require that timber management emulates natural disturbance events and does not systematically bias forest regeneration. The most current analysis found that the occurrence of many avian species differed between managed and unmanaged forests, suggesting that clearcutting does not mimic disturbance due to fire. More detailed studies are required to identify how clearcutting differs from fire and how timber management might be directed to maintain wildlife populations.)

(Hawkins, J.W.), (M.W. Lankester), R.A. Lautenschlager and F.W. Bell. 1997.
Effects of alternative conifer release treatments on terrestrial gastropods in northwestern Ontario.
For. Chron. 73(1): 91-98.
(Changes in terrestrial gastropod species richness and density in regenerating spruce plantations following application of 4 conifer release treatments are discussed. The lack of difference

following treatments was attributed to rapid re-establishment of the herbaceous layer, which probably continued to provide favourable conditions for snails and slugs.)

(Hawkins, J.W.), (M.W. Lankester), R.A. Lautenschlager and F.W. Bell. 1997.

Length-biomass and energy relationships of terrestrial gastropods in northern forest ecosystems.

Can. J. Zool. 75:501-505.

(Length-biomass models are a convenient and time-efficient method of estimating the biomass of invertebrates. Our purpose was to develop such a model for terrestrial gastropods that adequately predicted gastropod dry tissue biomass (y) on the basis of animal length (x). The power equation $Y = 0.172 \times 1.688$ ($r^2 = 0.85$) proved to be the best model for this purpose. Gastropod dry tissue biomass was 6.52 + 1.58 mg (mean+SE) and, based on gastropod densities ranging from 2 to 38/m^2 reported in the literature, snails and slugs active on the surface of the forest floor accounted for 2.5 and 6% of the total animal biomass and energy, respectively, of boreal forest ecosystems. However, because densities of gastropods in both the litter and underlying soil can reach 1607 m^2, our results suggest that published values for total animal biomass (4.9 g/m^2) and caloric energy (10 cal/m^2) in boreal forest ecosystems are underestimated.)

Kim, Y.T., (C. Glerum), D.F. Hickie and (C.P. Chen). 1997.

Effects of cold storage duration on carbohydrate and amino acid concentration, root growth potential, and growth of jack pine and black spruce seedlings.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 143. 18 p.

(The objective of this study was to determine the relationship between carbohydrate and amino acid changes, and growth of cold stored jack pine and black spruce seedlings. In comparison to spring-lifted stock, stored seedlings had lower levels of carbohydrates and higher concentrations of amino acids. Root growth potential was not significantly different between stored and spring-lifted seedlings. Changes in root growth potential could not be explained by any individual factor assessed in this study.)

Kostyk, B.C. and K.W. Wanner. 1997.

Control of insect damage to black spruce seed cones with neem.

N. J. Appl. For. 14(1): 40-43.

(A neem seed extract was applied to black spruce at 2 stages of reproductive development to control insect damage to the seed cones. After pollination, neem had no effect on damage by the spruce cone maggot but did provide some protection against defoliation by the spruce budworm. After 23 days, budworm populations declined on trees with 2 of 3 neem treatments compared to control trees. Neem reduced cone grazing damage by lepidopteran larvae when applied during the flowering stage. However, female flower abortion also increased. The use of neem seed extract to control spruce budworm damage appears promising.)

Kostyk, B., S. Greifenhagen and F.W. Bell. 1997.

Effects of alternative conifer release treatments on yellowheaded spruce sawfly defoliation.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Note No. 57. 4 p.

(Large populations of yellowheaded spruce sawfly were reported at the Fallingsnow Ecosystem Project site in northwestern Ontario. In 1995, the site was surveyed to determine if any of the 5 conifer release alternatives applied had affected the severity of sawfly defoliation in white spruce plantations. The type of release treatment used does not appear to affect defoliation by the yellowheaded spruce sawfly. Microsite conditions appear to be the most important factors influencing sawfly populations.)

Lautenschlager, R.A. 1997.
Biodiversity is dead.
Wildl. Soc. Bull. 3(1): 679-685.
(Biodiversity, the catch-all term for everything biotic, as well as for abiotic-biotic interactions, has become so all-inclusive that it has little more than "feel good" meaning. We need to identify and prioritize specific concerns in an ecosystem context. Identified and prioritized specifics provide the bridge from good ideas to realistic goals. Once these become clear, practices ranging from active management to complete protection can be implemented to address concerns in an ecosystem context.)

Lautenschlager, R.A. 1997.
Effects of perturbations and stimulants on red raspberry (*Rubus idaeus* L.) seed germination.
For. Chron. 73(4): 453-457.
(Red raspberry seeds germinate only after seed coats are degraded. Seeds from recently collected fruit germinated only after scarification of the seed coat by 20-minute soaking in concentrated sulfuric acid. Germination was not enhanced by: (1) short-term intermittent soaking, up to 81 hours, in dilute hydrochloric acid; (2) passage through the digestive tracts of bears, coyotes, or birds; (3) physical perturbations such as nicking, mechanical scarification, repeated freezing and thawing, and/or 4 years of exposure in the field; (4) exposure to light; (5) increased temperatures or temperature fluctuations; or (6) addition of nitrogen.)

Lautenschlager, R.A., F.W. Bell and R.G. Wagner. 1997.
Alternative conifer release treatments affect small mammals in northwestern Ontario.
For. Chron. 73(1): 99-106.
(Density changes of small mammals responding to different conifer release treatments were quantified. Small mammal responses to the alternative conifer release treatments examined were species specific 1 and 2 growing seasons post-treatment, but similar to responses common to the standard (Vision herbicide) conifer release treatment.)

Lautenschlager, R.A., F.W. Bell, R.G. Wagner and J.A. Winters. 1997.
The Fallingsnow Ecosystem Project: Comparing conifer release alternatives in northwestern Ontario.
For. Chron. 73(1): 35-38.
(The Fallingsnow Ecosystem Project documents the ecological consequences of alternative conifer release treatments in young spruce plantations. Biotic and abiotic changes caused by the cutting treatments were more similar to each other than to those resulting from the herbicide treatments, but statistical differences among treatments were few. Herbicide treatments were the most productive and least costly. About 60% of the active ingredient was deposited on the target foliage.)

Lautenschlager, R.A., (H.S. Crawford), (M.R. Stokes) and (T.L. Stone). 1997.
Forest disturbance type differentially affects seasonal moose forage.
Alces 33: 49-73.
(Wet-mass estimates and dry-mass conversions of species consumed by 3 tamed moose were made throughout the year in budworm defoliated, defoliated-clearcut, defoliated-clearcut-burned, and undefoliated 60- to 80-year-old spruce-fir stands. Natural and human-caused disturbances differ in their effects on forage production and moose use. Control and budworm defoliated plots produced the least and poorest quality forage. Forage production and use following cutting and controlled burns were similar. Wildfires increased short-term forage production more than the other disturbances examined.)

Lautenschlager, R.A. and (M.H.R. Browning). 1997.
Developing an ecosystem approach to achieving ecological sustainability — OMNR Science Forum overview.
For. Chron. 73(2): 267-272.
(Over 100 Ontario Ministry of Natural Resources staff met to discuss an *Ecosystem Approach to Ecological Sustainability*. Speaker presentations were interspersed with breakout groups where

participants were asked to address a number of issues including the development of a clear definition of an ecosystem approach, and the development of a practical action plan for implementing this approach. Plenary presentations included "What is sustainable ecosystem management", and "Natural and social scales in ecosystem management". Speakers addressed forest, wildlife, and ecosystem management strategies being studied and used in Canada. Regional and provincial action plans were developed and presented by the forum participants.)

Lautenschlager, R.A. and (M.H.R. Browning). 1997.
OMNR Science Forum 1996 — An ecosystem approach to ecological sustainability.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 136. 11 p. + append.
(In October 1996, over 100 Ontario Ministry of Natural Resources (OMNR) staff from across the province met at the Leslie M. Frost Natural Resources Centre in Dorset to discuss an *Ecosystem Approach to Ecological Sustainability*. Participants were asked to: (1) develop a clear definition as well as key components of an ecosystem approach to achieving ecological sustainability; (2) identify OMNR projects, programs, and practices that have taken that approach; (3) identify opportunities for implementing an ecosystem approach; and (4) develop a practical action plan for implementing an ecosystem approach. This report synthesizes the work of the breakout groups and outlines an action plan designed to help OMNR implement an ecosystem approach to ecological sustainability.)

Li, C. and A.H. Perera. 1997.
ON-FIRE: A landscape model for simulating the fire regime of northwest Ontario.
Pp. 369-392 *in* Ecological Research and Sustainable Development. China Environ. Sci. Press, ESCY Transaction 4.
(This paper describes the development of a landscape model, ON-FIRE, that simulates the natural forest fire regimes in northwestern Ontario. Approaches for simulating forest fire regimes are reviewed, the assumptions used in ON-FIRE are described, and some sample results from the model are discussed.)

Li, C., M.T. Ter-Mikaelian and A.H. Perera. 1997.
Temporal fire disturbance patterns on a forest landscape.
Ecol. Model. 99: 137-150.
(Potential temporal fire disturbance patterns on a forest landscape were investigated using a fire regime model with 4 different fire probability functions; (1) forest age-independent; (2) hyperbolic increase with forest age; (3) sigmoidal increase with age; and (4) linear increase with age. Simulation results on the case study area indicated that when the fire rotation period was fixed to 200 years, the predicted temporal disturbance patterns (average interval between 2 successive fires) were similar for small and intermediate fires, but different for large and severe fires. The sigmoid shape was most appropriate among the 4 tested fire probability functions. The average interval between 2 successive fires is: small fires every 5.8 years, intermediate fires every 34.4 years, and large fires every 151.6 years. Better prediction will require an explicit understanding of the quantitative relationship between fire probability and forest age.)

MacDonald, G.B., (R. Arnup) and (R.K. Jones). 1997.
Adaptive forest management in Ontario: A literature review and strategic analysis.
Ont. Min. Nat. Res., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 139. 38 p.
(Adaptive management is being advocated as an effective resource management framework by OMNR. This report outlines the basic concepts of adaptive management, provides examples of successful adaptive management initiatives in other jurisdictions, and evaluates the potential of adaptive management for improving forest policies and practices in Ontario.)

(Mallik, A.U.), F.W. Bell and (Y. Gong). 1997.

Regeneration behaviour of competing plants after clear cutting: Implications for vegetation management.

For. Ecol. Manage. 95:1-10.

(Regeneration characteristics and population dynamics of 4 major competing plants; trembling aspen, pin cherry, green alder, and beaked hazel, were studied from a 7-year-old clearcut in northwestern Ontario by determining their crown diameter, stem density, stem height, stem age, depth of sprouting centre, inter-sprout distance, and oven-dry weight of shoots and roots by nondestructive and destructive sampling. Stem density of trembling aspen and pin cherry in 1992 was 4,580 and 3,600 stems per ha, respectively, and 27,580 and 14,600 stems per ha for green alder and beaked hazel, respectively. Substantial reduction in stem density was recorded in trembling aspen (45%) and pin cherry (69%) over 2 years. Trembling aspen and pin cherry possess similar vegetative regeneration strategies that differ from those of green alder and beaked hazel. Based on species regeneration methods, 2 potential competition strategies were identified: a vertical competition strategy and a horizontal competition strategy.)

(Mallik, A.U.), (Y.L. Gong) and F.W. Bell. 1997.

Regeneration behaviour of competing plants after clearcutting.

Can. For. Serv., Great Lakes For. Cent., NODA Note No. 29. 6 p.

(The regeneration behaviour, population dynamics, and competitive ability of trembling aspen, pin cherry, green alder, and beaked hazel were studied to determine the nature and duration of competition on a 7-year-old jack pine plantation. Stem mortality was high in trembling aspen and pin cherry over 3 years, while stem densities remained much higher for green alder and beaked hazel. Aspen and cherry use a vertical competition strategy, whereas alder and hazel compete horizontally with crop plants. The regeneration characteristics of competing plant species and the level of tolerance of crop plants to competition will determine the need, timing, and method of vegetation control.)

(Meyer, W.L.), F.W. Bell, (P.J. Bastarache) and (C. Bowling). 1997.

Concepts of tree mineral nutrition related to fertilizer use in northern Ontario forests.

Ont. Min. Nat. Resour., Northwest. Sci. Technol., Tech. Rep. No. 114. 34 p.

(This paper reviews fundamental concepts of tree mineral nutrition related to fertilizer use as a silvicultural treatment in northwestern Ontario. Soil chemistry of essential nutrient elements is discussed. Concepts such as nutrient availability, mineralization, organic matter decomposition and weathering are reviewed. Critical nutrient concentrations for plant growth and interrelationships among nutrient ratios within the soil and plant are summarized.)

Mohammed, G.H. 1997.

Making the grade — A synopsis.

New For. 13(1-3): 3-6.

(This symposium is one of several meetings that have addressed the subject of plant assessment. Topics covered include: (1) the silver bullet — can one test do it all; (2) the designer seedling; (3) handling of seedlings; and (4) root growth potential, viability, and field performance. Advances in plant assessment were reviewed, as were future challenges. The opportunity for researchers to ensure that plant assessment stays relevant to the needs of forest regeneration was discussed.)

Mohammed, G.H. 1997.

The status and future of stock quality testing.

New For. 13(1-3): 491-514.

(Current tests being used for stock quality testing (SQT) are reviewed, indicating whether they are used on an operational or research scale. Prediction of growth by planting stock quality assessment is still not far advanced, and the operational application of physiological methods in particular in SQT is still limited, although progress varies according to country or region. Challenges in implementing operational SQT are reviewed, and a *total quality management* approach to addressing the challenges is proposed.)

Mohammed, G.H., P.H. Sampson, S.J. Colombo, T.L. Noland and (J.R. Miller). 1997.

Bioindicators of forest sustainability: Development of a forest condition rating system for Ontario. Project strategy.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON, For. Res. Inf. Pap. No. 137. 22 p.

(Measurable indicators of forest condition, which are both practical and scientifically sound, are urgently needed in Ontario and elsewhere. We present a strategy to develop a physiologically based approach to develop a Forest Condition Rating (FCR) system that uses remotely sensed spectral features to classify forests on a quantitative scale from healthy to stressed, relative to a benchmark or acceptable range of values. Calibration and development of the FCR scale will be done mainly by relating hyperspectral reflectance to ground-based assessments of stress status, health, and productivity of forest stands using plots from existing provincial networks as well as laboratory experiments and field trials. The FCR is intended to provide an early warning of pre-visual stress effects, and to support management decisions related to maintaining forest productivity. The capacity to rate forest condition using physiological methods would advance our ability to quantitatively evaluate the functional status of our forests.)

Mohammed, G.H. and T.L. Noland. 1997.

Influence of time of day and sampling methodology on chlorophyll fluorescence in jack pine (*Pinus banksiana* Lamb.), black spruce (*Picea mariana* (Mill.) B.S.P.), and eastern white pine (*Pinus strobus* L.).

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 142. 14 p.

(Diurnal changes in chlorophyll fluorescence (CF) (using the ratio of variable to maximal fluorescence, Fv/Fm) were followed in growth chamber and outdoor-grown healthy seedlings of jack pine, black spruce, and eastern white pine. In outdoor plants, decline in Fv/Fm occurred in all 3 species. Seedlings from all species grown under low light and constant moderate environmental conditions, had stable, high Fv/Fm throughout the day. In a second experiment, the effect of destructive harvest and cool or warm storage of shoots prior to CF measurement were investigated. No change was observed in the effective quantum yield of Photosystem II (change F/Fm') from pre-harvest levels, or warm or cool-stored for Fv/Fm. Destructive approaches were not appropriate for analysis of quenching parameters.)

Mohammed, G.H., T.L. Noland, W.C. Parker and R.G. Wagner. 1997.

Pre-planting physiological stress assessment to forecast field growth performance of jack pine and black spruce.

For. Ecol. Manage. 92:107-117.

(This study examined the possibility that pre-planting physiological assessment, after heat stressing, could be used to forecast stem volume increment after 4 years. Several stocktypes of black spruce and jack pine were exposed to 45-50°C of heat stress for 15-20 min in the dark, and planted on sites with or without competing vegetation control. Pre-plant physiology appeared to be useful in forecasting and distinguishing the competitive potential of the different stocktypes. Chlorophyll fluorescence parameters such as the ratio of variable to maximal fluorescence in black spruce and the difference between the maximum and the intermediate steady-state in jack pine, measured 1 day after the stress exposure, were more closely correlated to stem volume increment than photosynthetic rate or root growth potential.)

Noland, T.L. and G.H. Mohammed. 1997.

Fluorescein diacetate: A new viability stain for tree seeds.

Can. Tree Improv. Assoc. – Tree Seed Working Group News Bulletin 26:4-6.

(The objective of this study was to try to expand the application of fluorescein diacetate (FDA) by determining if FDA could be used as an effective viability stain for tree seeds and roots. FDA shows significant promise as a viability stain for tree

seeds. In all 7 tree species (green ash, jack pine, Scotch pine, red pine, eastern white pine, Austrian pine, and eastern hemlock) tested, FDA staining of embryos correlated well with percent germination provided the incubation period was long enough. Although further testing will be needed to confirm the efficacy and general applicability of FDA as a viability stain for tree seeds, it appears to have the potential to become the best method to quickly determine viability.)

Noland, T.L. and G.H. Mohammed. 1997.
Fluorescein diacetate as a viability stain for tree roots and seeds.
New For. 14: 221-232.
(Fluorescein diacetate (FDA) was tested as a viability stain for roots of green ash as well as for seeds of green ash and 10 other tree species. The viability level indicated by FDA staining of green ash roots agreed well with root growth potential results, bud condition assessment, and foliage browning measurements. When 2 seedlots of differing viability were tested in each of white spruce, Douglas-fir, and pitch pine, significantly higher germination was reflected in significantly higher embryo FDA staining intensity. FDA shows promise as a rapid viability stain for tree roots and seeds.)

Noland, T.L., G.H. Mohammed and M. Scott. 1997.
The dependance of root growth potential on light level, photosynthesis rate, and root starch content in jack pine seedlings.
New For. 13(1-3): 105-119.
(Number of new roots, new root length, photosynthesis, total nonstructural carbohydrate content of needles and roots, terminal bud condition, and shoot elongation were measured on jack pine container seedlings under greenhouse conditions simulating competition-induced lower light levels in the field. Lower light levels significantly reduced photosynthetic rate, root growth potential, new root length, total nonstructural carbohydrate (especially starch) content of needles and roots, speed of terminal bud flush, and shoot growth. Planting of jack pine seedlings on field sites with reduced light levels from interspecific competition may reduce root growth, survival, and reduced shoot growth.)

Obenchain, A.M. (ed.). 1997.
Insights.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. 2(2): 8 p.
(This issue of OFRI's newsletter highlights landscape-level planning tools and research to support criteria and indicators.)

Obenchain, A.M. 1997.
The more a seedling glows, the better it grows.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 2(2): 4.
(A short description of current fluorescence work that is being used to determine the vigour of seedlings and seeds.)

Obenchain, A.M. 1997 .
New computer tools help resource professionals "see" forest landscapes.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 2(2): 2-3.
(A brief overview of 2 new tools being developed: a hierarchial ecological framework for Ontario and a fire regime model, and information about when and how to use the models.)

Obenchain, A.M. 1997.
Why are criteria and indicators getting so much attention?
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 2(2): 4-6.
(This article defines criteria and indicators, lists the 6 criteria being used in Ontario and provides some examples of how research is supporting current criteria and indicator work at various scales.)

Papadopol, C.S. 1997.
Biotratamiento de residuos: Efluentes municipales reciclados con silvicultura. Prevención de la Contaninación
5(5): 6-13.

(Summary of the use of forest plantations to treat municipal waste products. (In Spanish).)

Parker, W.C., (S.R. Watson) and (D.W. Cairns). 1997.
The role of hair-cap mosses (*Polytrichum* spp.) in natural regeneration of white spruce (*Picea glauca* (Moench) Voss).
For. Ecol. Manage. 92:19-28.
(Natural regeneration of many North American conifer species frequently occurs in association with the hair-cap mosses. The role of *Polytrichum* mosses in the natural regeneration of white spruce was investigated through a comparative study of seedbed effects on seedling emergence, survival, morphology, and the presence of competing vegetation. Percent effective seedling emergence was significantly higher on mineral soil than on the other 3 seedbeds but did not differ among moss, litter, and burned litter. Seedling survival under a watering regime representative of the seedbed collection site did not differ among seedbeds. Survival of a short drought stress treatment, however, was significantly improved in mineral soil and moss as compared with the litter and burned litter seedbeds. Above- and belowground biomass of competition on the litter and burned litter seedbeds were significantly higher and 10 times that of mineral soil and moss seedbeds. The ecological relationship between white spruce and *Polytrichum* mosses and the comparative value of *Polytrichum* seedbed in silvicultural systems to promote natural regeneration of white spruce are discussed.)

Paterson, J. 1997.
Growing environment and container type influence field performance of black spruce container stock.
New For. 13(1-3): 329-339.
(Black spruce container stock grown in an uncontrolled outdoor environment outperformed stock grown in a controlled greenhouse environment in the first 2 years after field planting. Stem volume production in the field was greater for seedlings from larger volume containers grown at low densities than seedlings grown in a smaller volume container at a higher plant density. Cheaper alternatives to growing container stock in traditional greenhouses may be possible, while still maintaining or improving field performance attributes.)

Perera, A.H., D.J.B. Baldwin and F. Schnekenburger. 1997.
LEAP II: A landscape ecological analysis package for land use planners and managers.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 146. 88 p.
(The Landscape Ecological Analysis Package Version 2.0 (LEAP II) is a spatial decision-support tool for forest and other land managers. It is designed for the UNIX platform, partly based on FRAGSTATS raster computational routines. LEAP II lets the user explore, monitor, and assess a landscape for its ecological status once the management objectives are in place. The ecological concepts analyzed include patchiness, shape, isolation, edge, interior, connectivity, and material/organism movement. LEAP II has 3 user levels to allow varying degrees of sophistication. The guide introduces the user to landscape ecological concepts, describes how to install the software, presents several case studies, and provides step-by-step instructions for using LEAP II.)

(Pitt, D.G.), R.G. Wagner, (R.J. Hall), (D.J. King), (D.G. Leckie) and (U. Runesson). 1997.
Use of remote sensing for forest vegetation management: A problem analysis.
For. Chron. 73(4): 459-477.
(The potential for remotely sensed data to supplement field-collected forest vegetation management data was evaluated in a problem analysis consisting of a comprehensive literature review and consultation with remote sensing and vegetation management experts at a national workshop. Among currently available sensors, aerial photographs appear to offer the most suitable combination of characteristics, including

high spatial resolution; stereo coverage; a range of image scales; a variety of film, lens, and camera options; capability for geometric correction; versatility; and moderate cost. Recommended areas for research include: (1) digital frame cameras, or other cost-effective digital imagers, as replacements for conventional cameras; (2) computer-based classification and interpretation algorithms for digital image data; (3) relationships between image measures and physical measures, such as leaf-area index and biomass; (4) imaging standards; (5) airborne video, laser altimeters, and radar as complementary sensors; and (6) remote sensing applications in partial cutting systems.)

(Pitt, D.G.), (U. Runesson) and F.W. Bell. 1997.
Use of aerial photography for construction of vegetation maps on regenerating forest areas.
Pp. 196-203 *in* First North American Symposium on Small Format Aerial Photography. Cloquet, MN, 10-14 Oct. 1997. Am. Soc. Photogram. Remote Sens.,
(Stereoscopic photo-interpretation and digital spectral classification methods are compared for the construction of detailed vegetation maps of 4 young spruce plantations. In a parallel analysis, 1:5,000 photo negatives were scanned at 56 micron resolution and converted to positive digital images. These were then spectrally grouped on the basis of an interactive statistical clustering, followed by maximum likelihood classification. Results suggest that, with stereo photo interpretation, broad shrub and herbaceous classes can be estimated for individual strata with respectable precision. Estimates of less abundant components (low shrubs, grass, ferns, conifer, bare ground, and slash) may not be precise enough for some investigations. High spectral variability, caused by factors such as mixed species complexes, vertical structure, topography, and bi-directional reflectance reduced the spectral separability of classes on digital images. Spectral classification may need to be augmented by pattern, shape, and texture-recognition algorithms before automated image classification is feasible in this context.)

(Reynolds, P.E.), F.W. Bell, (J.A. Simpson), (A.M. Gordon), R.A. Lautenschlager, (D.A. Gresch) and (D.A. Buckley). 1997.
Alternative conifer release treatments affect leaf area index of competing vegetation and available light for seedling growth.
For. Chron. 73(1): 83-89.
(Leaf area index (LAI) of competing vegetation and photosynthetically active radiation (PAR) for spruce seedling growth were measured during the first growing season after alternative conifer release treatments were applied. The Vision treatment had significantly lower LAI than the brush saw, Silvana Selective, and Release treatments, and the control treatment had significantly greater LAI than all other treatments. Available PAR on a whole seedling basis ranged from 25% for control seedlings to 68% for seedlings released with Vision.)

(Reynolds, P.E.), (J.A. Simpson), R.A Lautenschlager, F.W. Bell, (A.M. Gordon), (D.A. Buckley) and (D.A. Gresch). 1997.
Alternative conifer release treatments affect below- and near-ground microclimate.
For. Chron. 73(1): 75-82.
(Li-Cor weather stations and thermistor/resistance soil cells were used during 1994 to monitor microclimate in young spruce plantations during the first growing season after 4 alternative conifer release treatments. Temperature, photosynthetically active radiation (PAR), and relative humidity (RH) were monitored near (0.25 m) and above (2 m) the forest floor. Soil moisture and temperature were read bimonthly. In relation to controls, PAR near and above the forest floor increased on all conifer release treatments. Duff and mineral soil temperatures were highest for the Vision and Release treatments. During the growing season after treatments, soil moisture levels were higher on treated than control plots.)

Sampson, P.H., C.W.G. Templeton and S.J. Colombo. 1997.
An overview of Ontario's Stock Quality Assessment Program.
New For. 13(1-3): 469-487.

(The purpose of the Stock Quality Assessment Program is to improve nursery stock quality and plantation performance by developing and applying procedures for assessing the physiological quality of nursery stock. Applying these tests has directly improved plantation establishment between 1992 and 1995 by preventing over 3 million damaged seedlings from being planted, at an estimated regeneration cost savings of over $2 million (Can).)

(Simpson, J.A.), (A.M. Gordon), (P.E. Reynolds), R.A. Lautenschlager, F.W. Bell, (D. Gresch) and (D. Buckley). 1997.

Influence of alternative conifer release treatments on soil nutrient movement.

For. Chron. 73(1): 69-73.

(Zero tension soil samplers were used to collect soil solution at 75 cm for 1 1/2 years after the following treatments: (1) helicopter-applied Release silvicultural herbicide (a.e. triclopyr @ 1.9 kg a.e./ ha), and (2) helicopter-applied Vision silvicutural herbicide (a.e. glyphosate @ 1.5 kg a.e./ ha); (3) motor-manual cutting (brush saws); and (4) control (no treatment). Results show no substantial treatment-related differences in the movement of selected nutrients (total organic N, NH4+, NO3-, K, Ca) among these treatments.)

Smith, D.J. and (M.E. Woods). 1997.

Red pine and white pine density management diagrams for Ontario.

Ont. Min. Nat. Resour., South Central Sci. Sec., North Bay, ON, Tech. Rep. No. 48. 32 p.

(The dynamic relationship between stand density and tree size can be used by the forest manager to enhance the volume production of a stand, or to influence the dimensions of individual stems. One of the most useful tools available is the density management diagram (DMD). A DMD is essentially a stocking chart for even-aged pure species stands that quantifies the dynamic nature of stand development. This paper presents DMDs for red pine and white pine. Four examples are provided to assist resource managers in using the diagrams.)

(Smith, W.) and G.H. Mohammed. 1997.

Inoculation with mycorrhizal fungi (*Hebeloma* spp.) can increase drought stress resistance and improve field performance of jack pine, black spruce, and white spruce.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 145. 10 p.

(In 1994, Mikro-Tek undertook a study to develop a test that would measure seedling stress resistance prior to planting. The test compared jack pine, white spruce, and black spruce seedlings inoculated with a selected species of mycorrhizal fungus to a non-inoculated control. Field measurements were taken in 1995 and 1996 to determine if seedlings that were more stress resistant during the greenhouse phase also performed better after outplanting. Inoculated crops showed a higher resistance to drought. In addition, in 11 out of 17 field trials, inoculated crops performed significantly better than non-inoculated crops after 1 or 2 growing seasons. Results show that stress testing and chlorophyll fluorescence may have practical applications for screening promising inoculant strains without having to wait at least 1 growing season.)

(Sullivan, T.P.), (D.S. Sullivan), R.A. Lautenschlager and R.G. Wagner. 1997.

Long-term influence of glyphosate herbicide on demography and diversity of small mammal communities in coastal coniferous forest.

Northwest Sci. 71(1): 6-17.

(This study tested the hypothesis that (1) abundance and related demographic parameters of small mammal populations, and (2) species diversity of small mammal communities, would be adversely affected in herbicide-treated habitats at 9 and 11 years after treatment in coastal coniferous forest. Study areas were located in south-coastal British Columbia, where small mammal populations were intensively sampled on paired control and treatment sites. It is likely that post-harvest succesional change has more of an impact on small mammal abundance than change induced by a herbicide treatment. Our results suggest that glyphosate herbicide did not

adversely affect reproduction, survival, or growth of deer mice and Oregon voles in coastal forest a decade after application. Species richness and diversity of small mammal communities changed little over the decade following treatment.)

Ter-Mikaelian, M.T. and (M.D. Korzukhin). 1997.
Biomass equations for sixty-five North American tree species.
For. Ecol. Manage. 97:1-24.
(This paper presents a comprehensive review of the biomass equations for 65 North American tree species. All equations are in the form $M=aD^b$, where M is the oven-dry weight of the biomass component of a tree (kg), D is diameter at breast height (cm), and *a* and *b* are parameters. Equations for total aboveground biomass, stem wood, stem bark, total stem (wood and bark), foliage, and branches (wood and bark) are included. The review is a unique source of equations that can be used to estimate tree biomass and/or to study the variation of biomass components for a tree species.)

Ter-Mikaelian, M.T. and R.G. Wagner. 1997.
Distance-independent models for predicting photosynthetically active radiation transmission through young forest plant canopies.
Can. J. For. Res. 27(1): 127-130.
(Two distance-independent models (Model 2, using individual-plant crown area, and Model 3, using species cover) for predicting photosynthetically active radiation (PAR) transmission through young forest plant canopies, were derived from a more complex individual-plant, distance-dependent model (Model 1). We found close agreement among PAR transmission values between Model 1 and Models 2 and 3 using data from a plant density study. Mean prediction errors between Models 1 and 2 were 0.34% and 1.09%. Mean prediction errors between Models 1 and 3 were 0.77% and 2.58%. The extinction coefficients estimated from Model 1 were used successfully in Models 2 and 3 without additional calibration.)

Ter-Mikaelian, M.T., R.G. Wagner, (C. Shropshire), F.W. Bell and (C.J. Swanton). 1997.
Using a mechanistic model to evaluate sampling designs for light transmission through forest plant canopies.
Can. J. For. Res. 27(1): 117-126.
(A mechanistic model was developed that predicts instantaneous photosynthetically active radiation (PAR) to evaluate 4 spatial and temporal questions about measuring light in a plant competition study. Light sampling schemes were evaluated for a 2-year-old plant density study with jack pine, large-leaved aster, and wild red raspberry. The model simulates PAR transmission through a plant canopy using 2 modules: a radiation module that simulates direct diffuse components of global PAR and a distance dependent vegetation module that simulates light interception by individual plants. Using this approach, we demonstrate how mechanistic models can be used to evaluate alternative experimental and sampling designs in field studies.)

Ter-Mikaelian, M.T., W.C. Parker and J.M. Paterson. 1997.
Photo imagery: A non-destructive method for estimating tree biomass.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 144. 10 p.
(Photo imagery is a promising non-destructive method for estimating the aboveground biomass of tree seedlings. This new method was tested using 9-year-old, naturally regenerated white spruce seedlings growing in the understory of a mixed conifer shelterwood. Regression analysis revealed a strong relationship between seedling biomass and projected area. These results demonstrate that photo imagery could be used as an alternative to more traditional methods of biomass estimation that use diameter or height as predictive variables. Photo imagery should be less expensive than traditional methods over the long term.)

(Thompson, D.G.), (D.G. Pitt), (B. Staznik), (N.J. Payne), (D. Jaipersaid), R.A. Lautenschlager and F.W. Bell. 1997.
On-target deposit and vertical distribution of aerially released herbicides.
For. Chron. 73(1): 47-59.

(Empirical studies were undertaken on 4 experimental spray plots with the objectives of: (1) quantifying mean on-target deposit and variability, (2) assessing the vertical distribution of active ingredient deposits through the vegetative complex, and (3) comparing herbicide deposit estimates on excised natural foliage with those on proximal collectors. For sites characterized by complex canopies, differential vertical deposition may be an important factor constraining the potential use of lower herbicide application rates, particularly where the shrub or groundcover species are important competitors. None of the artificial collector types tested accurately or consistently estimated true foliar deposit.)

Wanner, K.W., (B.V. Helson) and (B.C. Kostyk). 1997.
Foliar and systemic applications of neem seed extract for control of spruce budworm, *Choristoneura fumiferana* (Clem.) (Lepidoptera: Tortricidae), infesting black and white spruce seed orchards.
Can. Entomol. 129:645-655.
(Neem seed extract (20, 60, and 180 ppm azadirachtin) applied to the crowns of black spruce trees immediately prior to female reproductive bud flush, resulted in high mortality of early instar spruce budworm larvae. Dose-dependent reductions of 40-93%, as compared with check trees, were observed 2 and 4.5 weeks after treatment. Larval mortality and bud damage observed in the laboratory corroborated field results. High toxicity to second-instar larvae, and performance during adverse weather conditions, supports the potential of neem seed extract for controlling spruce budworm defoliation. Excellent protection of foliage was achieved from systemic injections of neem seed extract to white and black spruce trees (1.5 g azadirachtin/tree). Neem seed extract, formulated for systemic application, could provide a botanical alternative for control of forest pests in urban environments.)

Watt, J. 1997.
Using site-preparation alternatives to restore a Great Lakes-St. Lawrence conifer forest.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 2(2): 6-8.
(An overview of first-year results of an integrated project that is looking at the ecological effects of site preparation in Great Lakes-St. Lawrence conifer forests. Researchers are assessing machine efficiency and impacts on regeneration, seedling ecophysiology, microclimate, plant diversity, site productivity, and Armillaria root disease.)

(Woodcock, J.), R.A. Lautenschlager, F.W. Bell and (J.P. Ryder). 1997.
Indirect effects of conifer release alternatives on songbird populations in northwestern Ontario.
For. Chron. 73(1): 107-112.
(The effects of conifer release alternatives on songbird densities (determined by territory mapping, mist netting, and banding) in 4 young spruce plantations were examined. Post-treatment data revealed no major treatment-related changes in breeding bird species composition. Mean densities of the 11 most common species increased by 0.35/ha on the control plots during the first post-treatment growing season, but decreased on treated plots by 1.1/ha (brush saw), 1.6/ha (Silvana Selective), 0.14/ha (Release) and 0.72/ha (Vision).)

Publications 1998

Baldwin, D.J.B., (L.E. Band) and A.H. Perera. 1998.
A quantitative basis for using Ontario's existing ecoregionalization systems.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 151. 70 p.
(A quantitative basis for using 3 existing terrestrial ecoregionalization systems in Ontario was developed. Our objective was to quantify these systems with a multivariate set of geoclimatic variables, to determine their effectiveness in stratifying different ecological conditions in the province. We provided descriptive statistics and principal components analysis of each regional unit, comparison of multivariate distances and geologic similarity between units, as well as an

examination of the gradients of geoclimatic variables across the unit boundaries. No system was superior overall. The usefulness of these systems depends on the explicit definition of user goals and new reproducible systems are needed.)

Bell, F.W. and (D.G. Pitt). (comp.). 1998.
Third International Conference on Forest Vegetation Management: Post-conference tour guide.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON., Loose leaf binder.
(Daily summary of tourist stops and field projects visited during an 8-day combination sight seeing and forestry tour from Sault Ste. Marie to Thunder Bay. Topics covered include the history of forestry in northwestern Ontario and development of forest policy, harvesting and site preparation studies, regeneration work, tending, thinning, and integration trials. (*Not available for distribution.*))

Bell, F.W., (D.G. Pitt), (A.E. Morneault) and (S. Pickering). 1998.
Response of immature trembling aspen to season and height of cut.
Pp. 54-56 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(In 1993, a trial was initiated to examine the effect of height and season of motor-manual cutting on the number and size of aspen stem sprouts and root suckers. A factorial arrangement of treatments included 5 cutting heights (10, 25, 50, 75 and 100 cm above ground level) and 3 seasons of treatment: fall, winter, and summer. Response variables examined were density and height of new root suckers and the number and point of origin of pre-treatment branches and new stem sprouts. Cutting during mid-summer increases stem mortality, reduces the number of sprouts per stem, reduces the height of origin of sprouts, reduces overall sprout height, and reduces sucker height. In general, cutting during mid-summer, just below live crown, will maximize the effectiveness of motor-manual cutting on the regrowth of juvenile aspen.)

Bell, F.W., R.A. Lautenschlager, R.G. Wagner et al. 1998.
The Fallingsnow Ecosystem Project: An environmental assessment of alternative conifer release treatments.
Pp. 48-50 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(The Fallingsnow Ecosystem Project, located near Thunder Bay, Ontario, is an integrated, multi-disciplinary study established in 1993 to evaluate the effects of 5 alternative conifer release treatments on a number of environmental components in young spruce plantations. Researchers, from provincial and federal governments, universities, and the private sector, are working together to document and compare the effects of alternative conifer release treatments on soil nutrients, near-ground microclimate, vegetation, and wildlife. This project is providing forest managers with (1) data on the ecological effects of alternative vegetation management practices, (2) some of the first quantitative measures of biodiversity in managed northern forest ecosystems, (3) an example of how new and traditional practices need to be considered in an ecosystem context, and (4) an example of how co-operative research can address forest management problems.)

Bell, F.W. and R.G.Wagner. 1998.
Interference among boreal forest conifers and associated plant species.
Pp. 11-14 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141A. 140 p.
(The principle objective of this study was to determine the relative competitiveness of major

boreal forest plant species on jack pine and black spruce. The study is also being used to examine the machanisms of these interactions and other objectives. Nine selected competing plant species include herb, grass, fern, shrub, deciduous tree, and coniferous tree life forms.)

Bell, F.W., R.G. Wagner and M.T. Ter-Mikaelian. 1998.
Relative competitiveness of boreal plant species with jack pine and black spruce.
Pp. 51-53 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(Researchers are examining the relative competitiveness of 9 boreal plant species on planted seedlings of jack pine and black spruce using an additive density experimental design. Initial densities for woody plants (willow, alder, birch, aspen) were 0, 0.25, 0.5, 1.0, 2.0, and 4.0 plants m^{-2}. Non-woody herbaceous plants and low shrubs (aster, fern, fireweed, grass, raspberry) were established at 0, 0.5, 1.0, 2.0, 4.0, and 8.0 plants m^{-2}. The basal diameter growth of jack pine and black spruce were similar during the first 4 years of the study. For both spruce and pine, non-woody plants were more competitive than woody ones. Researchers also found that visual estimates of plant cover provided a good measure of their relative competitive effect.)

Bell, F.W. and S.G. Newmaster. 1998.
Fallingsnow Ecosystem Project: Floral richness, abundance and diversity.
Pp. 45-47 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(The paper describes and contrasts immediate changes in floral community diversity before and up to 3 growing seasons after alternative conifer release treatments. The clearcuts studied have rich and abundant floral communities even after conifer release treatments were applied. All conifer release alternatives affected the floral community with the herbicide treatments having an initially greater effect than the cutting treatments. By the third year post-treatment these differences were becoming less pronounced.)

Bell, F.W., W.C. Parker, (H.M. Kershaw) and (F.N.L. Pinto). 1998.
Autecology of forest plants.
Pp. 392-394 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(Autecology is the branch of ecology dealing with the study of relationships of individual organisms or species to environmental conditions. To understand the autecology of plants, information on the following factors is usually required: habitat, reproduction, propagation, growth habit, phenology, response to disturbance, interactions with other plant species, and interactions with mammals, birds, insects, and disease. This work summarizes why. With the focus on integrated forest management and development of vegetation management techniques to promote sustainable forestry, it is critical for forest managers to use information on plant autecology to predict how crop and non-crop species will respond to natural and silvicultural disturbances. Autecological knowledge will ensure more successful pre-harvest prescriptions and improved silvicultural strategies in the future.)

(Bruhn, J.N.), (J.D. Mihail) and T.R. Meyer. 1998.
Armillaria root disease inoculum remaining in young Ontario conifer plantations following root raking or madge rotoclearing.
N. J. Appl. For. 15(4): 191-196.
(*Armillaria ostoyae* infections mostly result from root invasions by rhizomorphs growing through the soil

from previously colonized stump and woody root debris. Stump and root removal by root raking alone often does not reduce subsequent root disease mortality. This investigation characterized residual woody debris volumes in 3 conifer seed orchards in northern Ontario. Regardless of site preparation method, Armillaria-killed trees were associated with greater total volumes of residual woody debris than were healthy trees. Rotoclearing followed by a fallow period of 8 years before planting merits consideration as an inoculum reduction treatment for site preparation.)

Buse, L.J. 1998.
Adaptive management: The future of forest management in Ontario?
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 3(1): 5-8.
(This article describes adaptive management, and explains how science fits into adaptive management, how adaptive management might be implemented in Ontario, and where to start.)

Candau, J.-N. and (R.A. Fleming). 1998.
Influences of climatic change on some ecological processes of an insect outbreak system in Canada's boreal forests and the implications for biodiversity.
Environ. Monitor. Assess. 49: 235-249.
(Insect outbreaks are a major disturbance factor in Canadian forests. If global warming occurs, insect disturbance patterns may change substantially, especially for those insects whose distributions depend largely on climate. Since the liklihood of wildfire often increases after insect attack, the unpredictability of future insect disturbance patterns adds to the general uncertainty of fire regimes. The rates of processes fundamental to energy, nutrient, and biogeochemical cycling are also affected by insect disturbance, and through these effects, potential changes in disturbance patterns indirectly influence biodiversity. A process-level perspective is advanced to describe how the major insect outbreak system in Canadian forests, that of the spruce budworm, might react to global warming. Some implications of this process-level perspective for managing the effects of global warming on biodiversity are discussed.)

Candau, J.-N., (R.A. Fleming) and (A. Hopkin). 1998.
Spatiotemporal patterns of large-scale defoliation caused by the spruce budworm in Ontario since 1941.
Can. J. For. Res. 28: 1733-1741.
(Survey records of spruce budworm defoliation in Ontario, taken annually since 1941, were analyzed using geographic information systems, spatial statistics, and time-series methods. Cumulative frequency maps indicated that 41 x 10^6 ha of Ontario had been defoliated at least once since 1941. Defoliation could be split into 3 zones of frequent defoliation separated by 2 approximately 100-km-wide, longitudinally oriented corridors of lower frequency. Analysis of annual records of the total area defoliated showed that fluctuations in the time series are the results of a basic oscillation of approximately 36 years, which is modified by secondary fluctuations and occasionally by sharp drops. The secondary fluctuations are at least partially due to asynchrony in otherwise remarkably similar long-wave oscillations in the eastern and western zones of frequent defoliation. Analysis of this asynchrony showed that outbreaks in the eastern zone occurred 5 or 6 years before outbreaks in the central and western zones, which were synchronous. These observations contradict previous reports of the large-scale spread of outbreaks from west to east.)

Cole, W.G. and (A. Harrison). 1998.
How to complete a topographic site survey.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Booklet. 14 p.
(This manual is intended as a step-by-step user's guide for the Nikon C-100 Total Station. It describes the process of completing a site survey and provides a helpful checklist of required equipment.)

Cole, W.G., (T. Gillis) and (W. Ripmeester). 1998.
Swan Lake Forest Research Reserve — Geographic information system.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. CD-ROM.
(The Swan Lake Forest Research Reserve is a 2,000 ha experimental forest established in 1950 in Algonquin Provincial Park. The Ontario Ministry of Natural Resources uses the reserve to study tolerant hardwood silviculture and stand dynamics, spruce genetics and stand dynamics, and more recently, brook trout and forest-lake ecotone ecology. The Swan Lake GIS is a PC ArcView 3.0x application and is the first comprehensive effort to compile and digitize spatial data from nearly 50 years of research and extension activities. Using custom-programmed buttons and pulldown menus, you can easily display, manipulate, and print data layers from the Ontario Base map (OBM) system, Forest Resource Inventory (FRI), and surficial geology, as well as local data on study locations and plot layouts, study metadata, and reserve building and utilities information. The software is distributed on 1 compact disc. (Cost is $25.))

Cole, W.G., (T. Gillis) and (W. Ripmeester). 1998.
Swan Lake Forest Research Reserve geographic information system — User's guide.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 140. 14 p. + append.
(The Swan Lake Forest Research Reserve is a 2,000 ha experimental forest established in 1950 in Algonquin Provincial Park. The Ontario Ministry of Natural Resources uses the reserve to study tolerant hardwood silviculture and stand dynamics, spruce genetics and stand dynamics, and more recently, brook trout and forest-lake ecotone ecology. The Swan Lake GIS is a PC ArcView 3.0x application and is the first comprehensive effort to compile and digitize spatial data from nearly 50 years of research and extension activities. Using custom-programmed buttons and pulldown menus, you can easily display, manipulate, and print data layers from the Ontario Base Map (OBM) system, Forest Resource Inventory (FRI), and surficial geology, as well as local data on study locations and plot layouts, study metadata, and reserve building and utilities information. This report explains how to use the software.)

Colombo, S.J. 1998.
Climatic warming and its effect on bud burst and risk of frost damage to white spruce in Canada.
For. Chron. 74(4): 567-577.
(Temperature data from 10 weather stations across Canada were used to model the effects of climate warming on the timing of bud burst and the risk of frost damage to white spruce. There was evidence of increasingly earlier dates of bud break over the course of this century at half of the stations examined, with the period 1981 to 1988 having the earliest predicted dates of bud burst. Weather data modelled for climate warming of 5°C predicts that bud burst will occur 2 to 4 weeks sooner than was the case during 1961 to 1980 at all stations, but that this will be accompanied by decreased risk of frost after bud burst. However, while the expected trend is one of reduced frost risk in the future, as the climate gradually warms frost risk is expected to fluctuate depending on interactions between provenance and local climate.)

Colombo, S.J. 1998.
What's happening in other jurisdictions — What's happening in Ontario.
Pp. 147-148 *in* Proceedings of the 1995, 1996, and 1997 Annual Meetings of the Forest Nursery Association of British Columbia. For. Nurs. Assoc. B.C.,
(A summary of recent changes in the tree seedling nursery industry in Ontario and the potential impacts of the transition on reforestation.)

Colombo, S.J., F.W. Bell and (E. Blumwald). 1998.
Phenology, needle wax, and resistance of black spruce to glyphosate damage.
Pp. 405-407 *in* Third International Conference on Forest Vegetation Management: Popular

summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(The experiments reported here were conducted to develop practical methods to determine glyphosate resistance of conifer seedlings. We report the role of needle wax on the resistance of black spruce to glyphosate during hardening. The first experiment was conducted to determine if bud development could be used as a guide to glyphosate resistance. The second experiment was designed to test the hypothesis that herbicide resistance primarily resulted from wax deposition on needles, preventing glyphosate uptake. We therefore hypothesized that resistance to glyphosate damage was due to the avoidance of glyphosate uptake rather than a function of physiological tolerance to the herbicide. Needle waxes seem to control glyphosate resistance in black spruce.)

Colombo, S.J., M.L. Cherry, (C. Graham), S. Greifenhagen, (R.S. McAlpine), C.S. Papadopol, W.C. Parker, (T. Scarr) and M.T. Ter-Mikaelian. 1998.

The impacts of climate change on Ontario's forests.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 143. 50 p.

(This report reviews literature concerning the effects of global climate change on forest plants and communities and provides author's opinions about the potential impacts that climate change may have on Ontario's forests. Areas covered include climate predictions, forest hydrology, insects, fungi, forest fires, plant physiological responses, genetic implications, vegetation dynamics, use of models, and opportunities for forest managers to respond to climate change.)

(de Groot, P.), F. Schnekenburger, (R.A. Fleming), and (J.J. Turgeon). 1998.

CONESYS: A data collection, database, and decision-support system for making insect pest management decisions in seed orchards.

North. J. Appl. For. 15(3): 154-157.

This paper provides an overview of CONESYS, a computer software package designed to assist seed orchard managers to collect, process, and store information about the quality and quantity of seed orchard crops. CONESYS also contains a database on cone and seed insects, registered pest control products and their efficacy, and a decision-support program that determines the costs and benefits of various pest management options.

DeYoe, D.R. 1998.

Respecting and linking different *real* worlds.

Pp. 35-47 *in* Extension Forestry: Bridging the Gap Between Research and Application. J.E. Johnson, ed. Blacksburg, VA, 19-24 July 1998. Third IUFRO Extension Working Party Symp.

(This paper discusses an approach used in Ontario that recognizes the features of science and operations professionals, identifies the gaps that present obstacles to transfer, then fills the gaps with professionals who serve applications, liaison, communication and/or transfer functions. The research-to-operations continuum and 3 case studies are presented.)

(Dumas, M.T.), S. Greifenhagen, G. Halicki-Hayden and T.R. Meyer. 1998.

Effect of seedbed steaming on *Cylindrocladium floridanum*, soil microbes and the development of white pine seedlings.

Phytoprotection 79: 35-43.

(The Egedal bed steamer produced sufficient heat to kill *Cylindrocladium floridanum* microsclerotia at 5- and 10-cm soil depths in a bareroot forest seedling nursery. At a second nursery, the innoculum was killed only to a depth of 5 cm. Soil steaming did not affect microsclerotia at 15 cm. Steaming reduced populations of fluorescent pseudomonads to undetectable levels to a depth of 20 cm and *Trichoderma* species were significantly reduced in the upper 10 cm of the seedbed. Density of white pine seedlings sown in the steamed beds was significantly higher, and height, root collar diameter, shoot weight, and root weight were significantly greater 4 months after steaming than that of control seedlings sown in unsteamed beds.)

(Fleming, R.A.), J.-N. Candau, (A.A. Hopkin), (T.R. Burns) and A.H. Perera. 1998.
A scaling problem encountered in the development of a landscape-level, spatially and temporally dynamic model of forest insect disturbances.
Pp. 169-174 *in* Scaling and Modelling in Forestry: Applications in Remote Sensing and GIS. D. Marceau, ed. Montreal, QC, 19-21 March 1998. Ministere des Relations internationales,.
(Typically the development of models of forest insect disturbance regimes are based, at least in part, on detailed studies of the insect's population dynamics. Models are developed at the scale of the experimental studies and then scaled up to the larger scale at which management decisions are made. When these models are nonlinear, as they often are, the process of scaling up can severely distort the output. A model for the spruce budworm provides a specific example. The identification and use of biologically defined scales offer a possible solution.)

Forest Landscape Ecology Program. 1998.
Ontario's forest fire history: An interactive digital atlas.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. CD-ROM.
(A digital atlas of Ontario's fire history from 1921-1995 packaged with analytical capabilities. User's guide published as Perera et al. 1998 Forest Research Report #147. *(Order from the Natural Resources Information Centre at 1-800-667-1940 for $30).*)

Greifenhagen, S. 1998.
How to identify gray mould on tree seedlings.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Brochure (bilingual).
(This bilingual brochure provides information about the mechanics of gray mould, how to identify it on seedlings, and how to minimize and manage the disease in greenhouses and storage. Colour photos add to its usefulness.)

Greifenhagen, S. and F.W. Bell. 1998.
Incidence of pine needle rust on the species interaction study sites.
Pp. 19-22 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141A. 140 p.
(A survey was conducted in 1996 to determine the extent of infection by rust on the study sites and to determine the relationship between weed density and disease intensity. A second study was conducted to assess disease progression, and its effects on growth and survival of the jack pine. These data will be used to provide quantitative information on the spatial dynamics of the *Coleosporium-Aster-Pinus* pathosystem relative to population density of the large-leafed aster. Trees were classed as infected, not infected, or dead. Pine needle rust could cause substantial jack pine mortality in young plantations under the following conditions: high aster density, pure aster competition, and clay sites.)

(Harvey, E.M.), F.W. Bell and (J.O. Boateng). 1998.
Manual, motor-manual, and mechanical brushing tools for conifer release.
Ont. Min. Nat. Resour., Northwest. Sci. Technol., Tech. Note No. 42. 12 p.
(This technical note summarizes current information about manual, motor-manual, and mechanical brushing tools as well as vegetation response following brushing. Included are tools such as shears, sandviks, machetes, brush hooks, axes, brush saws, and chain saws.)

(Houston, A.P.C.), (S. Visser) and R.A. Lautenschlager. 1998.
Microbial processes and fungal community structure in soils from clearcut and unharvested areas of two mixedwood forests.
Can. J. Bot. 76: 630-640.
(Decomposer fungi and microbial processes were examined in harvested and adjacent unharvested

areas of 2 mixedwood forests in northwestern Ontario. Soil microbial processes and fungal community structure were similar in harvested and unharvested stands. Although reductions were not significant, basal respiration, microbial biomass carbon, metabolic quotients, microbial carbon to organic carbon ratios, and nitrogen mineralization tended to be lower in organic soil from the harvested sites than the unharvested sites, with the exception of metabolic quotients. Fungal community structure and dominance was similar in soil in harvested and unharvested sites. When comparing organic and mineral soil layers, fungal richness, diversity, and community composition corresponded more closely in the harvested than unharvested sites. Isolation frequencies of all frequently found fungal species were equivalent in soil from harvested and unharvested sites.)

(Houston, A.P.C.), (S. Visser) and R.A. Lautenschlager. 1998.

Response of microbial processes and fungal community structure to vegetation management in mixedwood forest soils.

Can. J. Bot. 76: 2002-2010.

(This study was conducted to evaluate whether microbial processes and decomposer fungi were sensitive to manual or chemical vegetation management in addition to harvesting and site preparation. Three vegetation management treatments were applied to 3 clearcut and prepared sites 2 years prior to the initiation of the study. Four treatments were established within each site: harvested (control), glyphosate herbicide (Vision), triclopyr herbicide (Release), and brushsaw. Relative to the harvested control, vegetation management had no significant effect on fungal community structure as evidenced through rank abundance curves and indices of fungal community richness, diversity, evenness, or dominance. Although the abundances of the majority of fungal species were not affected by vegetation management, herbicide and brushsaw use decreased the isolation frequencies of *Mortierella vinacea* and *Paecilomyces carneus*, respectively. Two years after vegetation management was imposed there were no detectable effects on basal respiration, microbial biomass carbon, metabolic quotients, microbial carbon to soil organic carbon ratio or nitrogen mineralization in either the organic or mineral soil layers compared with measurements made in the harvested control plots.)

(Irvine, M.T.), R.G.Wagner, (D.R. Clements) and (C.J. Swanton). 1998.

Growth response of bareroot eastern white pine nursery stock to multi-species weed competition. Pp. 130-132 *in* Third International Conference on Forest Vegetation Management: Popular Summaries.

R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(Objectives of this study were to describe the effect of multi-species weed competition on eastern white pine bareroot nursery stock in terms of absolute and relative seedling growth rates, and allometric growth. Weed-free and weed-infested curves were developed from measurements of seedlings in plots kept weed-free or weed-infested, respectively, until measurement. Tree seedlings grew much less under herbaceous competition; weed-free and weed-infested seedlings began to diverge in size at the beginning of the critical period of weed control, coinciding with a great increase in weed biomass.)

(Kelly, C.P.), (H.G. Cumming) and R.A. Lautenschlager. 1998.

Recovery of woody moose browse 3, 4, and 8 years, and performance of crop trees 1 to 4 years after aerial application of glyphosate.

Pp. 136-138 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(Several studies have documented the initial decline in browse availability 1 to 2 years following conifer

release treatments with various herbicide products. Few studies have supplied data for more than 2 years following treatment. This study assesses moose browse availability on 20 sites in northern Ontario at various longer intervals after treatment. Browse availability can be assessed as early as 4 years following release. Treated areas have more browse than control areas.)

(Kenkel, N.C.), (P.R. Watson) and P.W.C. Uhlig. 1998.
Modelling landscape-level vegetation dynamics in the boreal forests of northwestern Ontario.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 148. 151 p.
(This study was undertaken to develop a synoptic model of forest succession (vegetation dynamics) in the boreal ecoregion of northwest Ontario. Successional trends were inferred using 2 complementary approaches: the analysis of size class distributions of trees and species vital attributes; and the enumeration of stands at different post-fire ages. A sample of the 1389 plots enumerated within the approximately 184,000 km^2 study area were used in this study. Within each 10 x 10 m plot, percent cover estimates were obtained for all vascular plants and terricolous cryptogams. Cover values for trees and tall shrubs were enumerated in each of 4 vertical strata. The synoptic succession model recognizes 2 self-perpetuating forest canopy types. The black spruce type occurs primarily in nutrient-deficient sites, while the mixedwood (fir-spruce-birch) type occurs where nutrients are less limiting.)

(Kuessner, R.), (P.E. Reynolds) and F.W. Bell. 1998.
Growth response of black spruce seedlings as affected by competition for radiation.
Pp. 145-147 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(The objectives of this study were to quantify competition of different species under controlled conditions via measurements of effective leaf area index and to evaluate the effect of competition for radiation on black spruce growth. On clay sites, white birch, Canada blue-joint grass, fireweed, and red raspberry generated high mean leaf area index on mid-crown position of black spruce resulting in a decrease in black spruce stem volume of more than 50% compared to released seedlings. On loam sites, Canada bluejoint grass and fireweed reduced stem volume of black spruce to less than 40% of control seedlings.)

Lautenschlager, R.A. 1998.
Aldo Leopold — An early vegetation management advocate.
Pp. 166-168 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(A look at the writings of Aldo Leopold in relation to forest vegetation management in its broadest sense — from planting and competition control through harvesting.)

Lautenschlager, R.A. 1998.
Aldo Leopold — Thinking like a forester.
For. Chron. 74(5): 697-699.
(A look at the writings of Aldo Leopold in relation to forest vegetation management in its broadest sense — from planting and competition control through harvesting.)

Lautenschlager, R.A. 1998.
Effects of forest harvesting and conifer release on small mammals in northern ecosystems.
Pp. 79-82 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141A. 140 p.
(This summary covers the effects of harvesting in general, and post-harvest conifer release treatments

in particular, on small mammals (species and populations) in northern ecosystems. Major changes in small mammal species composition and populations at a site, stand, watershed, or forest level result from disturbances, such as forest harvesting. Those disturbances change the structure and composition of the forest. However, silvicultural treatments, like conifer release, that follow cutting, have much less effect on small mammals. In general, total densities and biomass of small mammals decrease immediately after any catastrophic disturbance like clearcutting, and less so after less catastrophic disturbances like partial cuts and single-tree selection. Biomass and densities increase soon after any disturbance and are affected little by regeneration practices such as conifer release; they decrease again in pole-sized stands and begin to increase again as the stand reaches and passes silvicultural maturity.)

Lautenschlager, R.A. 1998.

Environmental resource interactions affect red raspberry and its competition with white spruce.

Pp. 163-165 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(The objectives of this study were to determine the effects of light, water, and nutrients on the growth of red raspberry seedlings, and the effects of intra- and interspecific competition for light, nitrogen, and space on interplantings of red raspberry and white spruce seedlings. When provided with an abundance of nitrogen, light, and with spruce neighbours, raspberry expanded at the expense of the spruce. When grown with raspberry, spruce consistently maintained a higher shoot/root ratio than raspberry, illustrating both the stress-tolerant nature of the spruce and raspberry's ability to sequester available resources and conditions for its growth.)

Lautenschlager, R.A. 1998.

From rhetoric to reality: Using specific environmental concerns to identify critical sustainability issues.

Ecosystems 1: 176-182.

(Natural resource managers, environmental interest groups, and public agencies are interested in appropriate, identifiable, and measurable indicators of sustainability. The *Identify the Specifics* approach, described here, uses local ecological/biological *experts'* knowledge to identify and prioritize the local natural resources of concern, associated management practices and ecosystems to form a *concern matrix*. Scale-specific matrices identify appropriate local, regional, and broader-scale indicators to monitor and assess, and provide public agencies with direction for documenting effects of management and identifying where research is needed. This approach can provide ecosystem-based, prioritized information for balancing social, economic, and ecological concerns on public and private lands.)

Lautenschlager, R.A. 1998.

In northwestern Ontario conifer release causes few small mammal density changes.

Pp. 157-159 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(The objective of this study was to determine the effects of conifer release, using standard herbicide technology and alternative treatments, on small mammal species composition and densities. Described are study design, treatments, trapping, statistical analysis, and nomenclature. Approximately 7,000 small mammals, representing 14 species, were captured and released during this study. Although there were significant density differences between treated and check plots during the first growing season after treatment, consistent differences in small mammal species and/or

densities were not observed between the standard herbicide (Vision ®) and proposed alternative treatments. No alternative maintained consistently higher densities of all the common small mammal species in the Fallingsnow small mammal community.)

Lautenschlager, R.A. 1998.

The role of ecosystem studies in ecosystem management.

Pp. 169-171 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(Ecosystem studies (ES) have not been defined, even in publications recommending extensive ecological research. Seemingly appropriate ESs have been conducted at micro/mesocosum, operational, and watershed scales. This summary looks at the role of ecosystem-level research in resource management.)

Lautenschlager, R.A., F.W. Bell, R.G. Wagner and (P.E. Reynolds). 1998.

The Fallingsnow Ecosystem Project: Documenting the consequences of conifer release alternatives.

J. For. 96(11): 20-27.

(The Fallingsnow Ecosystem Project is documenting the terrestrial ecological consequences of alternative conifer release treatments. Although long-term responses are unknown, results to date indicate that cutting and herbicide treatments are relatively inconsequential for most environmental components found in regenerating northern forests, including soil nutrients and species richness of vegetation, insects, gastropods, amphibians and reptiles, songbirds, and small mammals. Still, given the growing opposition to herbicide use in forestry, managers must expect that social input into natural resource management will become more common if not required.)

Lautenschlager, R.A., (T.P. Sullivan) and R.G. Wagner. 1998.

Terrestrial responses to alternative conifer release treatments in northern ecosystems — A review.

Pp. 160-162 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(The objective of this paper is to review, based primarily on literature identified by Sullivan and Sullivan's (1997) compendium, the responses of terrestrial ecosystem components to conifer release. In addition to reviewing the published literature, we also speculate about potential ecosystem responses to alternative treatments, which have not been studied extensively. In general, forest harvesting, not conifer release, had the greatest effects on the terrestrial ecosystem components examined. Effects of post-cutting treatments like conifer release were generally minimal. This is because plants and animals colonizing post-cut areas are disturbance-tolerators or followers, and conifer release treatments are relatively mild disturbances applied to previously severely disturbed areas.)

Lautenschlager, R.A., (W.J. Dalton), (J.L. Graham) and F.W. Bell. 1998.

Conifer release treatments increase trembling aspen forage quality slightly in northwestern Ontario.

Pp. 154-156 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(This study was designed to compare the effects of 2 herbicides, 2 cutting types, and no treatment on digestible dry matter (DDM) and digestible protein (DP) of 3 plant species commonly eaten by both moose and white-tailed deer in boreal mixedwood ecosystems. Of the 3 species examined, only

trembling aspen exhibited short-term (2 growing seasons posttreatment) increases in growing season DDM and DP following conifer release. The species-specific differences in forage quality observed are likely of greater importance to deer, which commonly select higher quality forage, than to moose which select quantity.)

MacDonald, G.B. 1998.
Enhancing conifer regeneration in aspen-dominated mixedwood stands.
Pp. 182-184 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(In this study we tested the effects of harvest intensity, weeding frequency, and site preparation on the survival and growth of planted white spruce and jack pine seedlings in mixedwood stands dominated by trembling aspen, and assessed the effects of the treatments on understory hardwood growth and species richness. The treatments included 3 harvest intensities (uncut, 50% shelterwood cut, and clearcut), 3 weeding frequencies (none, single, and multiple), and 2 site preparation levels (not scalped and scalped). Third year survival of white spruce was greater than that of jack pine for all treatments. Survival was significantly affected by harvesting, but not by weeding. Survival in the uncut treatment was low for both species (55% for spruce, 40% for pine), but increased to acceptable levels in harvested plots. Scalping produced no significant responses in seedlings or other vegetation. Survival data indicate that white spruce is more suitable than jack pine for mixedwood stands.)

MacDonald, G.B. and (R.G. Cormier). 1998.
Commercial utilization of the boreal mixedwood forest.
Ont. Min. Nat Resour., For. Manage. Br., Sault Ste. Marie, ON, Boreal Mixedwood Notes No. 21. 8 p.
(This note describes current and potential future use of boreal mixedwood forests and species as well as possible value-added products from this forest type. Recommendations for improving boreal mixedwood utilization in Ontario are provided. (Available from NRIC as part of Mixedwood Note Series.))

(MacDonald, L.M.) and T.R. Meyer. 1998.
Determination of imidacloprid and triadimefon in white pine by gas chromatography/mass spectrometry.
J. Agric. Food Chem. 46(8): 3133-3138.
(Imidacloprid is one of a new class of highly systemic chloronicotinyl insecticides with significant activity against a wide range of insects. The triazole fungicides, triadimefon and triadimenol, are also systemic and highly effective in controlling a variety of economically important fungal diseases. A sensitive and reliable method for determining these compounds by gas chromatography/mass spectrometry (GC/MS) has been developed. This method has been successfully applied to quantify in-plant residues after treatment of white pine seedlings with a controlled-release pellet containing imidacloprid and triadimefon. Mean recoveries for QC samples were 85.62%.)

(McLaughlin, C.G.) 1998.
Habitat allometry: Evaluating changes in species richness using species-area models.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Landscape Ecol. Program: For. Fragment. Biodiv. Proj. Rep. No. 23. 28 p.
(Species richness often declines as the size and continuity of natural habitats is reduced. Detecting real changes in species richness requires reliable measurement tools. Species-area curves can provide baselines for measuring changes in species richness, but little is known of their variation among taxa and at differing spatial scales. Ratios constructed from species-area curves – for bird species and mammal species in the same areas, and among mammal species in different areas – illustrate the relative differences in the increase of species with area, suggesting the potential to predict such differences. Species-area curves may be reliable models for predicting the effects of reductions and isolation of habitat areas on one taxon from knowledge of the effects on other taxa. However, current published data are inadequate for producing such models.)

Mohammed, G.H., P.H. Sampson, S.J. Colombo, T.L. Noland and (J.R. Miller). 1998.

Physiological bioindicators: Scaling up from tree to stand.

Pp. 35-38 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. 141A. 140 p.

(Our approach to scaling up from plant to canopy or stand involves the following steps: review technology; establish a plot network; apply ground-based physiological assessments; correlate ground-based physiology to canopy and stand-level airborne hyperspectral imagery; determine seasonal, species, and annual effects on physiology; differentiate overstory and understory; test for landscape-level assessment; scale-up spectral sampling to spaceborne hyperspectral apparatus; test active methods of remote sensing; and delineate forest condition rating categories from remotely sensed spectra. Leaf-based spectral indices in the visible and near infra-red seem to be useful indicators of stress and are correlated with other physiologically based measures. Certain spectral indices may be appropriate for physiological scale-up to canopy or stand, but require further testing.)

Mohammed, G.H. and T.L. Noland. 1998.

Weeds aren't all bad! Pharmaceutical prospects for common Ontario species.

Pp. 448-450 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(Historically, about 500 of Ontario's plant species have been used medicinally by aboriginal and other peoples for a variety of common ailments and in disease prevention. Many of these species grow as *weeds* on forest sites and are routinely controlled using chemical herbicides. Alternatively, some of these weeds may supply useful botanical products that could enhance the economic value of the forest landbase of Ontario. This work looks at some alternate uses for common Ontario species.)

Mohammed, G.H., T.L. Noland and R.G. Wagner. 1998.

Physiological competitive tolerance in jack pine in the presence of herbaceous vegetation.

Pp. 208-210 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(Here, containerized stocktypes of 2 sizes, Multipot 1-67 and 6-45, were planted in the presence or absence of competing herbaceous vegetation and their respective physiological performances followed over the first season. Physiological features measured were chlorophyll fluorescence, gas exchange, water potential, glutathione (GSH) concentration, and foliar macronutrient concentration. Photosynthetic rate in 1-67 seedlings was lower in grass than in no-grass plots. Macronutrient levels in 6-45 trees were higher than in 1-67 trees in grass plots. In contrast, nutrient concentrations in 6-45 trees were either similar between treatments or even enhanced in the grass plots. A major effect of competing vegetation was the reduction of light intensity.)

Mohammed, G.H., T.L. Noland and R.G. Wagner. 1998.

Physiological perturbation in jack pine (*Pinus banksiana* Lamb.) in the presence of competing herbaceous vegetation.

For. Ecol. Manage. 103: 77-85.

(The effects of herbaceous competing vegetation on 2 containerized stocktypes of jack pine were investigated to assess their relative competitive tolerance in the first year after planting. Stocktypes were of similar genetic origin and age, but differed in initial size. First-season survival of Multi-pot 1-67 and 6-45 seedlings was 37% and 60%, and diameter increment was 0.25 mm and 0.33 mm, respectively, in the presence of competition. Competitive tolerance was reflected in mid- to late-season physiology: the larger stocktype maintained higher macronutrient

concentration and photosynthetic performance, as well as greater capacity to protect tissues from photooxidative damage. These findings contribute to our understanding of how size-based differences in competitive ability may be manifested physiologically.)

(Moola, F.M.), (A.U. Mallik) and R.A. Lautenschlager. 1998.
Effects of conifer release treatments on the growth and fruit production of *Vaccinium* spp. in northwestern Ontario.
Can. J. For. Res. 28: 841-851.
(Berry production and vegetative recovery of lowbush and velvetleaf blueberry were documented for 3 growing seasons after brushsaw, single operational, and multiple non-operational Vision herbicide (a.i. glyphosate), and control treatments in a jack pine plantation in northwestern Ontario. Lowbush blueberry fruit production was significantly reduced by both the single and multiple treatments in all 3 years of the study. Velvetleaf blueberry fruit production was only reduced by the multiple treatment. Compared with the controls, reductions in cover for both blueberry species were only significant with the Vision treatments. In clearcuts where lowbush blueberry forms a major component of the *Vaccinium* spp. cover, the short-term reduction in fruit availability in sprayed areas may be significant.)

(Morneault, A.E.), F.W. Bell and (D.G. Pitt). 1998.
Improving the effectiveness of motor-manual and mechanical cutting.
Pp. 119-122 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141A. 140 p.
(Evidence from research studies and operational treatments suggest that the effectiveness of motor-manual cutting can be improved through an understanding of the autecology of target species and modification of cutting operations to minimize sprouting of dogwood, aspen, alder, ash, birch, cherry, and maple. Demonstration plots illustrate this marriage of autecological principles and operational practice to maximize efficacy. Operational experience suggests that carbohydrate reserves in aspen stem and root systems fall steadily after leaf flush, through to the end of the growing season, as carbohydrates are used for tissue production in zones of active growth. Study results indicate that to minimize regrowth, cut basal sprouting species (e.g., alder) below 10 cm and cut root-suckering species (e.g., aspen) above 50 cm during the growing season. To maximize regrowth, cut basal sprouting species above 10 cm, and root-suckering species below 25 cm during the dormant season.)

(Morneault, A.E.), W.C. Parker, (B.J. Naylor), T.L. Noland, F.W. Bell, S.G. Newmaster, (D.C. Othmer), (L.C. Duchesne), (M.E. Woods), (D.M. Burgess), (S.S. Wetzel) and (F.N.L. Pinto). 1998.
Ecological effects of site preparation in white pine stands managed under the shelterwood system.
Pp. 454-456 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(The objectives of our study are to examine the effects of the regeneration cut of the shelterwood system and 4 site preparation techniques on the following selected components of white pine ecosystems: overstory, growth, plant diversity and succession, carabid beetles, salamander populations, and downed woody debris. The study was established using a randomized complete block design, with 5 treatments replicated in 3 blocks. The treatments are: 1) no cut, no site preparation, 2) cut and no site preparation, 3) cut and mechanical site preparation, 4) cut and chemical site preparation, and 5) cut and both mechancial and chemical site preparation.)

(Newmaster, S.G.), (A. Lehela), (P.W.C. Uhlig), (S. McMurray) and (M.J. Oldham). 1998.
Ontario plant list.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 123. 550 p. + append.
(This plant list includes more than 4,700 species, including vascular plants, bryophytes, and lichens,

that grow in Ontario. Information about phytogeography, rarity, a vegetation alpha code system, and botanical nomenclature is presented. For each species the following information is provided: family, genus, and species names; up to 4 scientific synonyms; up to 2 common names; a French name if available; vegetation code; Bayer code; rarity status; numeric life form code; and a life cycle code. Three indexes (Latin, English, French) have been included to provide easy access to all plant names. (*Order from the Natural Resources Information Centre at 1-800-667-1940 for $30.*)

Newmaster, S.G., F.W. Bell and (D.H. Vitt). 1998.
The effects of silvicultural herbicides on common bryophytes and lichens in northwestern Ontario.
Pp. 223-225 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(The effects of silvicultural herbicides on the ecology of bryophytes and lichens are poorly understood. In this study, the effects of applying triclopyr and glyphosate to bryophyte and lichen communities is investigated over a period of 2 years. For each plot, all bryophytes and lichens were identified and listed by cover before, and at 6 weeks, 1 year, and 2 years after treatment. Results from this research indicate that bryophytes and lichens have a species-specific response to herbicides. The mesophytic forest species exist as remnants in harvested sites and can be eradicated using only half of standard herbicide concentrations. Therefore, herbicide treatments may result in a site lacking forest mesophytes and abundant with a few colonizing species for at least 2 years post treatment. Recovery of forest mesophytes via the soil spore bank or spore dispersal from local refugia or missed strips needs to be investigated.)

Noland T.L., G.H. Mohammed and R.G. Wagner. 1998.
Competition tolerance of bareroot and container seedlings of jack pine, white pine, and black spruce.
Pp. 49-52 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap.141A. 140 p.
(One objective of this study was to use results from pre-plant biochemical and physiological tests performed before or after heat stressing to forecast subsequent stem volume growth on a field site with herbaceous competition after 5 years. A second objective was to compare performance of different container (CON) and bareroot (BR) stocktypes after 5 years. Seedlings were planted on a flat site with a medium sandy soil. Jack pine, eastern white pine, and black spruce were planted as small and medium CON seedlings. White pine and black spruce were medium and large BR seedlings, while only medium BR jack pine seedlings were planted. Glyphosate was applied by backpack sprayer to one-half of each block for the first 3 years to control vegetation. Results indicated that larger BR stocktypes usually perform better under competition. Post-stress chlorophyll fluorescence results may be useful to forecast field performance in conifer. If initial quality of a seedling lot is inconsistent, pre-plant test results are unlikely to forecast future field performance.)

Noland T.L., G.H. Mohammed and R.G. Wagner. 1998.
Competition tolerance of bareroot and container seedlings of jack pine, white pine, and black spruce.
Pp. 233-235 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(One objective of this study was to use results from pre-plant biochemical and physiological tests performed before or after heat stressing to forecast subsequent stem volume growth on a field site with herbaceous competition after 5 years. A second objective was to compare performance of different container (CON) and bareroot (BR) stocktypes after 5 years. The cumulative 5-year percent stem volume increase was greatest in the small and/or medium

CON for all 3 species. Relative growth was the greatest in the medium CON (multipot) of jack pine and the small container of white pine. Small and medium black spruce CON seedlings grew about equally well over the 5-year period. The veg:no veg (V:NV) ratio of the 5-year percent stem volume increase indicates that in jack pine and black spruce, the BR stocktypes grew best under herbaceous competition. In white pine, the medium CON and the large BR stocktypes had the highest V: NV ratios and therefore grew the most under herbaceous competition conditions.)

(Obbard, M.E.), (B.A. Pond) and A. Perera. 1998.
Preliminary evaluation of GPS collars for analysis of habitat use and activity patterns of black bears.
Ursus 10:209-217.
(Prototype radiocollars incorporating global positioning system receivers were attached to 8 adult female bears in northern Ontario in 1994. The GPS receiver accessed the coarse/acquisition code, so accuracy of system horizontal position was expected to be 100 m (i.e., 95% of fixes will be within 100 m of true position). Units were set to acquire GPS fixes at 3-hour intervals. At the end of the monitoring period, there were no detectable collar-induced injuries, nor any difference in behaviour compared to bears with conventional radiocollars. Of the collars successfully recovered, collars on 3 bears in open habitat (recent burns, young stands) acquired fixes 50, 50, and 65% of the time, whereas the collar on the bear under more closed canopy acquired fixes only 32% of the time. Fine-grained analysis of fixes and satellite-derived landcover did not show a significant difference between the fixes obtained by GPS and conventional radiotelemetry under different landcover types.)

Obenchain, A.M. 1998.
***Bioindicators Project* to develop new approach for monitoring forest condition.**
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 3(2): 2-3.
(This article highlights some of the projects that are part of the developmental stages of a forest condition rating system that is based on remote sensing imagery.)

Obenchain, A.M. 1998.
Changes in forest management could help minimize effects of climate change.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 3(2): 3-4.
(A discussion of the potential effects of climate change on forests in Ontario including speculations about wood supply, biodiversity, and land-use planning issues. Some preliminary recommendations are provided.)

Obenchain, A.M. (ed.). 1998.
Insights.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. 3(1): 8 p.
(This issue of OFRI's newsletter highlights plant competition studies, adaptive management, and new GIS tools.)

Obenchain, A.M. (ed.). 1998.
Insights.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. 3(2): 8 p.
(This issue of OFRI's newsletter highlights new challenges for Ontario's forest growth and yield program, new approaches for monitoring forest condition, and options for minimizing the effects of climate change on forests.)

Obenchain, A.M. 1998.
Leap II: A user-friendly tool for analyzing forest landscapes.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 3(1): 7.
(See Forest Research Report No. 148; Perera et al. 1997.)

Obenchain, A.M. 1998.
New GIS tool captures 50 years of research at historic reserve in Algonquin Park.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 3(1): 6.
(See Forest Research Information Paper No. 140; Cole et al. 1998.)

Obenchain, A.M. 1998.

New information on plant competition will improve early conifer survival, growth.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 3(1): 1-5.

(The article covers studies looking at which species are most competitive and why, natural regeneration of white pine, when vegetation management is most successful, and how to predict which seedlings can handle competition.)

Obenchain, A.M. 1998.

OFRI publishes comprehensive list of Ontario's plant species.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 3(2): 7-8.

(This article highlights the Ontario Plant List (Forest Research Information Paper No. 123; Newmaster et al., 1998), which provides a master list of Ontario's plants including common and scientific names; synonyms; standard alpha codes; codes for rare, threatened and endangered species; and identifiers relating to medicinal values.)

Obenchain, A.M. 1998.

Ontario's forest growth and yield program: Gearing up for the 21st century.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 3(2): 5-6.

(This article describes the development and future direction of Ontario's provincial forest growth and yield program.)

Parker, W.C. 1998.

The growth response of white spruce seedlings to seasonal timing of mechanical release from understory woody competition in an Ontario shelterwood.

Pp. 242-244 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(This summary presents results of the effects of seasonal timing of mechanical release on the growth of suppressed white spruce advance reproduction. Seedlings released from hardwood competition were significantly taller and had larger basal stem diameters than control seedlings 2 years after release. White spruce seedlings responded by increasing lateral branch increment and the number of needles produced in each branch increment. Total leaf area and leaf dry mass produced in a growing season were higher than the shaded, control seedlings.)

Parker, W.C. and F.W. Bell. 1998.

Silvicultural and ecophysiological aspects of vegetation management for regeneration of white pine (*Pinus strobus* L.).

Pp. 135-138 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141A. 140 p.

(While operational treatments for management of competitive species are being developed and improved, knowledge of thresholds for white pine under competition with these species singly, or in combination, can be used to further improve the timing and efficiency with which vegetation management treatments are applied. Moreover, an understanding of competition effects on white pine ecophysiology will enable development of mechanistic rather than empirically based silvicultural prescriptions for white pine regeneration. Performance of natural and artificial regeneration of white pine on this site was controlled primarily by competition for light, and comparative differences in light interception by the competitors (i.e., shading: fir>hazel>fern). Third-year survival, diameter, crown area, and stem volume of planted white pine seedlings were negatively associated with cover of competitive vegetation. Third-year height of planted seedlings was not strongly related to cover of competitive vegetation, but was reduced in treatments with high cover values. White pine natural regeneration beneath a fern canopy exhibited better growth than

pine under fir and hazel canopies. White pine natural regeneration exhibited a large, positive stem volume growth response following motor-manual release.)

Paterson, J.M., W.C. Parker, F.W. Bell and (D. Cormier). 1998.
Rehabilitation of Great Lakes-St. Lawrence forest ecosystems: Management impacts assessment (MIA) project.
Pp. 464-466 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(The objectives of this project are to (1) assess the ecological impacts of alternative site preparation techniques and (2) develop cost effective, ecologically sustainable forest management practices for the rehabilitation of Great Lakes-St. Lawrence conifer forest ecosystems. We compared heavy raking with a bulldozer-mounted rake with: (1) light raking using a bulldozer-mounted rake, (2) mulching of the full site with the Meri-Crusher MJ-2.3, (3) strip-mulching with the Meri Crusher MJ-0.8, (4) scalping using an excavator-mounted rake, and (5) an unprepared control treatment. Initial results suggest that the white pine is performing best on the raked and excavator sites, whereas the growth of white spruce is favoured on the mulched and untreated sites. Survival tended to drop as planting difficulty increased, with the untreated control plots exhibiting poorest survival.)

Peng, C.H., D. Smith and J. Hayden. 1998.
Understanding the role of forest simulation models in sustainable forest management.
Pp. 245-247 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(This paper reviews and compares 3 major types of forest simulation models: 1) growth and yield models, 2) succession models, and 3) process-based models. A potential approach for integrating forest simulation models with a decision-support system, which will become an important tool for evaluating the sustainability of forest ecosystems under a changing environment, is also discussed. Traditional forestry objectives aimed at sustainable yield management are being replaced with those of sustainable ecosystem management. This paradigm shift in forest management must be supported by an effective transfer of results from researchers to forest managers. Forest simulation models have proven useful for assessing the effects of forest practice, climatic change, fire disturbance, and harvesting on future forest growth and dynamics.)

Peng, C.H., (J. Guiot) and (E. van Campo). 1998.
Past and future carbon balance of European ecosystems from pollen data and climatic model simulations.
Global Planet. Change 18:180-200.
(As climate changes, there is considerable uncertainty whether northern hemisphere ecosystems will act as atmospheric CO_2 sinks or sources. We used statistical models calibrated on field measurements, past terrestrial biomes and climates inferred from pollen, and future climatic change scenarios simulated by General Circulation Models, to investigate the processes controlling past, present, and future CO_2 fluxes in European ecosystems. Our results suggest that climate change can significantly affect spatial and temporal variations of net primary production and soil respiration, and alter the net ecosystem exchange of CO_2. Most terrestrial biomes in Europe will likely change from a net CO_2 sink to a net CO_2 source. The results further illustrate that there is no analogue in the recent past (late Quaternary) for future ecosystem dynamics.)

Peng, C.H., (J. Guiot) and (E. van Campos). 1998.
Estimating changes in terrestrial vegetation and carbon storage: Using palaeoecological data and models.
Quart. Sci. Rev. 17:719-735.
(Palaeoecological records provide not only past records of vegetation patterns at various spatial and

temporal scales, but also a means of evaluating the associated changes in past terrestrial carbon storage. This paper provides a brief review of the role of paleoecological data and biosphere models in evaluating the potential impacts of past climate change on terrestrial ecosystems and synthesizes methods for reconstructing vegetation patterns from the data and integrating it with biosphere models to reconstruct long-term terrestrial carbon dynamics since the last glacial maximum (LGM). Colder, more arid, and low atmospheric CO_2 climatic conditions at the LGM may have favoured the extensions of steppe and grassland dominated by C4 plants, to the detriment of forested ecosystems. However, the warmer and wetter climatic conditions during the Holocene favoured extensions of temperate deciduous forests in mid-latitudes and reduced the tundra and taiga forest at high latitudes. Carbon storage in terrestrial vegetation was relatively low during the full-glacial time and increased to a maximum during the mid-Holocene. Further progress in understanding the dynamic processes of global vegetation and carbon cycle will require both the development of a global palaeoecological database and the development of biosphere models.)

Peng, C.H. and (M.J. Apps). 1998.

Simulating carbon dynamics along the Boreal Forest Transect Case Study (BFTCS) in central Canada 2. Sensitivity to climate change.

Global Biogeochem. Cycles 12(2): 393-402.

(The effects of climate change and doubling of atmospheric CO_2 on carbon dynamics of the boreal forest in the area of the Boreal Forest Transect Case Study in central Canada were investigated using the process-based plant-soil model CENTURY 4.0. The results suggest that across the transect climate change would result in increased total carbon and vegetation biomass but decreased overall carbon in soil; increased atmospheric CO_2 concentration under current climatic patterns would result in increased total carbon in vegetation and in soil organic matter, and combined climate change and elevated CO_2 would increase both net primary productivity and decomposition rates relative to current climate, but their combined action would be a reduction of soil carbon losses relative to those due to climate change alone. Present simulations indicate that northern sites are more sensitive to climate change than the southern sites are, but these simulations do not consider likely changes in the disturbance regime or changes in forest species distribution.)

Peng, C.H., (M.J. Apps), (D.T. Price), (I.A. Nalder) and (D.H. Halliwell). 1998.

Simulating carbon dynamics along the Boreal Forest Transect Case Study (BFTCS) in central Canada

1. Model testing. Global Biogeochem. Cycles 12(2): 381-392.

(CENTURY 4.0, a simulation model of carbon (C) and nitrogen (N) dynamics of terrestrial ecosystems based on the relationships between climate, soil texture, plant productivity, decomposition, and human management, was tested against observed data along the boreal forest transect case study (BFTCS) in central Canada. The simulated average aboveground biomass and net N mineralization were consistent with observed data. The modelled estimates for soil C were consistent with those from regional-scale empirical regression models. The effects of climatic variation on temporal changes in biomass and soil C storage over the past century were found to be very different for southern and northern sites but relatively insensitive to site-specific soil texture. The main discrepancies between observed data and CENTURY 4.0 results are associated with the effects of soil texture and an inadequate representation of fire disturbance on C dynamics of boreal forests. Further improvements, particularly in the representation of disturbance regimes and in the simulation of slow pool C dynamics, are suggested to enhance its predictive capability.)

Perera, A.H. 1998.

An integrated spatial toolbox for forest landscape planning and management.

Pp. 43-45 *in* GIS '98/RT '98 Conference Proceedings: Pathways to Knowledge Integration. Toronto, Ont., 6-9 April 1998. Adams/GIS World, (A logical framework and a GIS-based toolbox for forest landscape management is presented. Generically, the suite of integrated, spatial tools includes landscape generators, landscape processors, landscape analysts, and landscape assessors. The Ontario version of this toolbox contains a comprehensive spatial database in addition to the decision support and simulation systems. Based on this data, a landscape generator predicts the maximum likelihood potential natural vegetation series. Simulation of the major landscape processes is done by integrated fire regime and pest regime models. Given the landscape, its physical environment and disturbances, another landscape processor predicts the primary productivity and hydrological output. A landscape analyst/monitor quantifies the landscape spatial pattern in terms of diversity, fragmentation, and connectivity. Next in the sequence are the multiple landscape assessors such as habitat supply models, wilderness quality models, timber supply models, and conservation gap analyses. This framework provides a logical basis for exploration and a user-friendly platform for simulating many what-if spatial scenarios.)

Perera, A.H. and D.J.B. Baldwin. 1998.

Spatio-temporal patterns of Ontario's young forests: A landscape perspective.

Pp. 248-250 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p. (Our objective here is to describe the large-scale spatial characteristics and patterns of the forest created by recent harvest and fire in the northern Ontario landscape. The forest polygon parameters quantified include internal composition, spatial geometry, distribution by various templates, and association with various geo-physical variables. During the 35-year period 1960-1995, 11.5% of the managed forest area of Ontario has been harvested and 3.46% has been burned.)

Perera, A.H., D.J.B. Baldwin, F. Schnekenburger, (J.E. Osborne) and (R.E. Bae). 1999.

Forest fires in Ontario: A spatio-temporal perspective.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 147. 22 p.

(Forest fires are of considerable ecological, economic, and social importance in Ontario. Knowledge of forest fire regimes is essential for policy development for fire management, timber harvesting, and of late, sustainable forest management. We have developed a CD-ROM-based digital atlas of the forest fire history of Ontario to provide information about past fire regimes. This report describes the methods used in developing the GIS database of fire history and the systems architecture of the software package. In addition, we provide a description of the range of capabilities of the fire history atlas for quering and analyzing spatio-temporal fire information with examples and a users guide. See FLEP 1998 for CD-ROM.)

(Pitt, D.G.) and F.W. Bell. (comp.). 1998.

Third International Conference on Forest Vegetation Management: In-conference tour guide.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141A. 140 p. (Following the success of the previous international conferences (Auburn, Alabama, USA, 1992; Rotorua, New Zealand, 1995), this third conference focuses on (1) alternative methods of vegetation control, (2) ecosystem effects associated with vegetation management practices, and (3) ecosystem management and its implications for forest vegetation management. This document includes 3-page popular summaries for the in-conference field tour presentations at the Third International Forest Vegetation Management Conference held in Sault Ste. Marie, Ontario, Canada from August 24-28, 1998. (*Out of print.*))

(Pitt, D.G.), F.W. Bell, (R.A. Campbell) and (A. Obarymskyj). 1998.

Herbicide use in Canadian forest management.

Pp. 123-126 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141A. 140 p.

(The objectives of this presentation are to outline the nature and extent of herbicide use in Canadian forest management, and illustrate several application methods and typical efficacy levels in a trembling aspen-dominated weed complex. There are currently 4 active ingredients in general use in Canadian forest management: glyphosate (provides broad-spectrum control of most deciduous woody species, broadleaf herbaceous weeds, and grasses); triclopyr (provides broad-spectrum control of most woody plants and does not suppress grasses and other monocots); 2,4-D (has a use pattern similar to triclopyr and is particularly effective on pin cherry, birch, and alder); and hexazinone (provides good control of most herbaceous weeds). Application methods include aerial, ground, directed foliar, basal bark, cut stump, and stem injection. Herbicides continue to play a significant role in operational vegetation management. Glyphosate accounts for more than 95% of Canadian forest herbicide use. Glyphosate and triclopyr generally address the majority of Canada's conifer release needs; a broad-spectrum, soil-active site-preparation herbicide is still needed. More than 85% of all silvicultural herbicides are applied by air. Selective, low-impact manual techniques are proving valuable in sensitive areas.)

(Pitt, D.G.), (U.T. Runesson) and F.W. Bell. 1998.

Constructing detailed vegetation maps of forest regeneration areas using aerial photography.

Pp. 251-253 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(In this study, we assess the potential for classical stereo photo interpretation and computer-based spectral classification to produce spatially accurate, quantitative vegetation maps of regenerating forest areas. We suspect that, beyond broad classification of low spatial resolution imagery, computer-based classification algorithms will only become practical when they include texture-, shape-, and pattern-recognition routines or, perhaps, operate within a decision-support environment. It seems that classical photo interpretation is an art that we should not be quick to dismiss, even as we move into the digital era.)

(Prezio, J.R.), (M.W. Lankester), R.A. Lautenschlager and F.W. Bell. 1998.

Effects of alternative conifer release treatments on terrestrial gastropods of regenerating spruce plantations.

Pp. 266-268 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(This study compares terrestrial gastropod populations 2 and 3 years after the application of Vision®, Release®, mechanical, and motor-manual conifer release treatments. Gastropods were collected each month from June-September, during the second and third summers (1995 and 1996) following initial treatment. Gastropod densities (numbers m^{-2}) recorded from the 4 blocks were analyzed using a repeated measures analysis of variance to test for differences between treatments throughout the 4 sampling periods. Several factors contribute to the overall, long-term success of terrestrial gastropods in boreal ecosystems. Large recorded changes in gastropod density were correlated with annual fluctuations in rainfall. Although the short-term effect of herbicides alone on gastropod populations appears to be minimal, when combined with poor climatic and habitat conditions, significant reduction in numbers may result.)

(Reynolds, P.E.), F.W. Bell, (R. Kuessner) and (N.V. Thevathasan). 1998.

Determining the effects of controlled weed densities and soil types on black spruce microclimate, physiological responses, and growth.

Pp. 31-34 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141A. 140 p.

(Objectives of the current research are to determine the severity of competition by various species in affecting black spruce survival and growth, and to determine how this varies with soil type, weed density, and the number of years of weed establishment. Observations include: weed growth (all species) is most severe on clays; competition for light is greater on clays; competition for water/nutrients is greater on sands/loams; soil nitrates have primarily benefitted weeds; competition is more severe with herbaceous species; and severity of weed competition is species dependent.)

(Reynolds, P.E.), (N.V. Thevathasan), (J.A. Simpson), (A.M. Gordon), R.A. Lautenschlager, F.W. Bell, (D.A. Gresch) and (D.A. Buckley). 1998.

Alternative conifer release treatments affect soil nitrogen mineralization rates.

Pp. 281-283 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(The study was initiated (1) to quantify changes in soil nitrogen mineralization rates resulting from alternative release treatments, (2) to assess the duration of these treatment-related changes, and (3) to relate soil nitrification rates to soil temperature and moisture. Increases in soil nitrogen mineralization following conifer release treatments were presumably caused by treatment-related vegetation reductions and ensuing microclimatic changes. Vegetation reductions led to increased soil moisture and solar radiation reaching the forest floor, which warmed the soil. Vegetation reductions were greatest on the glyphosate treatment. Soil nitrogen mineralization increases were short-lived, with no significant treatment-related differences observed after 2 growing seasons, probably because of rapid regrowth of vegetation and the gradual loss of favourable post-treatment increases in soil temperature and moisture.)

(Reynolds, P.E.), R.A. Lautenschlager, (J.A. Simpson), F.W. Bell, (A.M. Gordon), (D.A. Buckley) and (D.A. Gresch). 1998.

Microclimate changes following conifer release treatments continue through three post-treatment growing seasons.

Pp. 275-277 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(This study documents below- and near-ground microclimatic changes associated with several alternative conifer release treatments in the boreal mixedwood forest type. Objectives were to quantify treatment-related microclimatic changes and to determine the duration of the changes. All release treatments in 1993 resulted in numerous microclimate changes during the 1994 growing season, but these changes were greatest and lasted longest after herbicide release. The changes were favourable for enhanced seedling growth. Microclimate changes were greatest for the glyphosate treatment where succession to non-woody vegetation had occurred. By 1996, most treatment-related differences in microclimate were associated with the glyphosate and unharvested forest treatments.)

(Reynolds, P.E.), (R. Kuessner) and F.W. Bell. 1998.
Effects of controlled weed densities and soil types on seedling microclimate.
Pp. 278-280 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(Objectives of this study were to quantify summer soil temperatures, soil moisture, and photosynthetically active radiation (PAR) for black spruce seedlings at varying weed densities established on 2 soil types (clay and loam) and to assess the effects of these microclimatic parameters on seedling growth. We conclude that microclimate was most affected by soil type, followed sequentially by weed species, and weed density. PAR and soil temperatures were reduced most on clay soils as weed leaf area indices increased. Generally, herbaceous species competed more severely for PAR and reduced soil temperatures more than deciduous woody competitors.)

Rice, J.A., (M.E. Woods) and (B.D. Batchelor). 1998.
Silvicultural calibration of Algoma/North Shore stands — A progress report.
Ont. Min. Nat. Resour., South Central Sci. Sect., Tech. Rep. No. 103. 22 p.
(Forest managers in the Algoma/North Shore region of central Ontario have recently begun using silvicultural systems as the basis for managing tolerant hardwood stands. Regional stocking and structural guidelines have been developed for the selection system in central Ontario. However, locally developed guidelines for the use of selection and shelterwood systems are lacking in the Algoma/North shore area. Differences in site, climate, and cutting history in the Algoma/North Shore area suggest that a modified set of guidelines, sensitive to these local conditions, is required to ensure a continuous flow of high quality forest products while maintaining wildlife habitat, aesthetics, and other forest values.)

(Robinson, D.E.), R.G. Wagner, F.W. Bell and (C.J. Swanton). 1998.
The influence of competing vegetation on jack pine (*Pinus banksiana* Lamb.) photosynthesis and soil resource use.
Pp. 27-30 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141A. 140 p.
(This study attempts to explain the influence of weed species, weed density, and years after establishment on jack pine photosynthesis and resource use efficiency (of moisture and nitrogen) from field experiments. An additive series incorporating a split-plot, randomized block design for 2 crop trees, jack pine and black spruce, and several competitors were replicated on sand, loam, and clay soils. Monthly measurements of photosynthesis, transpiration, and foliar nitrogen were made on 6 jack pine per treatment. Results indicate that jack pine photosynthesis decreased significantly between 0.0 and 2.0 plants/m^2, regardless of weed species or year. Herbaceous weeds had the greatest negative influence on conifer photosynthesis in the first year of the study; woody weeds had the greatest negative influence in the second year of the study. Jack pine may compete most effectively for soil resources through the efficient use of resources, rather than rapid uptake.)

(Robinson, D.E.), R.G. Wagner, F.W. Bell and (C.J. Swanton). 1998.
Mechanisms of nitrogen competition of jack pine seedlings competing with important forest plantation weeds.
Pp. 287-289 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(The influence of weed species, weed density, and years after establishment on jack pine

photosynthesis and its relationship with nitrogen use efficiency was determined from field experiments conducted at the Ontario Forest Research Institute arboretum. An additive series incorporating a split-plot, randomized block design for the crop trees, jack pine and black spruce, and several weed competitors was replicated on sand, loam, and clay soils. Monthly measurements of photosynthesis, transpiration, and foliar nitrogen were made on 6 jack pine per treatment. Results showed that jack pine photosynthesis decreased with increasing weed density. We also found an interaction between weed species and years after establishment. Jack pine photosynthesis increased linearly with nitrogen use efficiency. Jack pine competed more effectively with all weeds as nitrogen use efficiency increased, rather than through a rapid uptake of available soil resources.)

Sampson, P.H., G.H. Mohammed, S.J. Colombo, T.L. Noland, (J.R. Miller) and (P.J. Zarco-Tejada). 1998.
Bioindicators of forest sustainability: Progress report.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 142. 18 p.
(Measurable indicators are needed to gauge the effects of management activities and natural phenomena on forest sustainability. To meet this need, the Bioindicators of Forest Sustainability Project is testing physiological approaches to develop a Forest Condition Rating (FCR) system. Development of an FCR system involves interpreting remotely sensed spectral information with the aid of ground-based assessments of structural and functional (i.e., physiological) aspects of forest condition. Current research activities include controlled laboratory studies, ground-based field assessments and acquisition of hyperspectral airborne data to develop gradients in key spectral features that correspond to actual differences in physiology. This report provides first-year progress results, and a brief summary of collaborative projects and proposed research activities.)

Sampson, P.H. and S.J. Colombo. 1998.
Applied physiology: Ontario's stock quality assessment program.
Pp. 39-42 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141A. 140 p.
(Ontario's Stock Quality Assessment (SQA) Program provides nursery managers and foresters with tests such as root growth potential and chlorophyll fluorescence to determine stock viability or vigour. The SQA Program offers 2 levels of testing: Seedling Certification (which provides some assurance that stock being shipped from nurseries is viable) and Problem Stock Testing (which provides an initial examination of seedling viability within 48-72 hours). The SQA Program improves nursery stock quality and plantation performance by assessing the physiological condition of stock prior to planting. The benefits of an impartial, quantitative, physiological assessment of nursery stock far outweigh the risks of costly failures and reduced productivity. By applying standardized testing conditions, nursery stock can be compared on a consistent basis; from year-to-year and among nurseries. Test information facilitates decisions as to whether nursery stock is suitable for planting, which provides a valuable link in relating cultural practices to eventual field performance. Field portable techniques, such as the chlorophyll fluorometer and the gas analysis system, are promising advancements in meeting on-site needs of nursery managers and foresters.)

(Shropshire, C.), R.G. Wagner, (C.J. Swanton) and F.W. Bell. 1998.
Light attenuation patterns under competitive forest plant canopies.
Pp. 23-26 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap.141A. 140 p.
(The objectives of this study are to describe how the 9 plant species differ in their spatial and temporal

ability to intercept light over 2 successive growing seasons, and evaluate the usefulness of measures of plant density (percent cover, leaf area index, and stem density) to predict PAR transmission. Measurements were obtained from 3 randomly selected 1 m^2 subplots in each treatment plot during the second and third years of the study (1995 and 1996). The weed species that consistently intercepted the most PAR over the growing season in both years were Canada bluejoint grass and wild red raspberry. PAR transmission decreased to varying degrees as plant density increased.)

(Shropshire, C.), R.G. Wagner, (C.J. Swanton) and F.W. Bell. 1998.

Light attenuation patterns under competitive forest plant canopies.

Pp. 311-313 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(In this study, we (1) described how 8 plant species differed in their spatial and temporal ability to intercept light over 2 successive growing seasons, and (2) evaluated various measures of plant abundance (percent cover, leaf area index, and stem density) for their ability to predict photosynthetically active radiation (PAR) transmission through these plant canopies. Each of the selected plant species were established at 6 densities ranging from 0 to 8 plants m^{-2}, in association with jack pine seedlings planted at a fixed density of 1 seedling m^{-2}. PAR transmission was measured at ground level and jack pine crown level using a 1-m-long LI-COR line quantum sensor. The plant species that consistently intercepted the most PAR over the growing season in both years were Canada bluejoint grass and wild red raspberry. The relationship between PAR transmission and plant abundance was linearized by logarithmic transformation, and a multiple linear regression model was developed for each year. Plant species differed in their ability to intercept PAR in their second and third growing seasons.)

(Sullivan, T.P.), (C. Nowotny), R.A. Lautenschlager and R.G. Wagner. 1998.

Silvicultural use of herbicide in sub-boreal spruce forest: Implications for small mammal population dynamics.

J. Wildl. Manage. 62(4): 1196-1206.

(This study was designed to test the hypothesis that herbicide-induced habitat alteration would reduce small mammal populations in early successional stages of sub-boreal spruce forest. A secondary objective was to determine the long-term influence of herbicide treatment on reproduction, survival, and growth attributes of deer mouse and southern red-backed vole populations. Small mammal populations were intensively sampled in 4 pairs of control and treated sites dominated by early successional vegetation near Prince George, BC between 1987 and 1992. Higher mean numbers of red-backed voles and shrews were present on control than treatment sites between 1988 and 1992. Mean abundance of meadow voles and deer mice were similar on control and treated sites throughout the study. The magnitude of observed demographic effects from herbicide treatment were well within the mean values of natural fluctuations of these variables. Herbicide treatment of areas dominated by early successional vegetation in northern coniferous forests should be staggered in time and space to allow recovery of vegetation and small mammal species.)

(Sullivan, T.P.), (D.S. Sullivan), (E.J. Hogue), R.A. Lautenschlager and R.G. Wagner. 1998.

Population dynamics of small mammals in relation to vegetation management in orchard agroecosystems: Compensatory responses in abundance and biomass.

Crop Prot. 17(1): 1-11.

(This study tests the hypothesis that habitat alteration with intensive herbicide (glyphosate) treatment would adversely affect the small mammal community in apple orchards. Multiple applications of herbicide were applied to the total orchard floor in 2 experimental orchards, and in a 2-m-wide strip within tree rows only in a third orchard. Intensive

sampling of montane vole, deer mouse, and northwestern chipmunk populations was conducted in replicate control and treatment blocks of apple orchards at Summerland, British Columbia, Canada from 1983 to 1986. Average abundance of voles declined by 53% to 73% on treatment compared to control blocks after the first herbicide application. Either deer mouse and northwestern chipmunk populations were significantly higher on treatment than control blocks or there was no difference in abundance after the start of the herbicide applications. There were no significant differences in biomass of small mammals between control and treatment populations in summer and winter periods in 2 out of 3 orchards. There appears to be a 'compensatory response' in this small mammal community whereby deer mice and northwestern chipmunks have essentially 'replaced' the montane vole on treatment blocks in an orchard agroecosystem.)

(Sullivan, T.P.), R.G. Wagner, (D.G. Pitt), R.A. Lautenschlager and (D.G. Chen). 1998.
Changes in diversity of plant and small mammal communities after herbicide application in sub-boreal spruce forest.
Can. J. For. Res. 28(2): 168-177.
(This study tests the hypothesis that herbicide (glyphosate) application for conifer release would reduce species diversity (measured as richness, Simpson's index, and Shannon-Wiener index) of both plant and small mammal communities over a 5-year period. Indices of shrub diversity, however, were not different over the 5 years. Neither herbaceous species diversity or diversity of small mammal communities was affected by herbicide treatment.)

Ter-Mikaelian, M.T., F.W. Bell and R.G. Wagner. 1998.
Influence of competing vegetation on jack pine (*Pinus banksiana* Lamb.) and black spruce (*Picea mariana* [Mill.] B.S.P.) diameter growth.
Pp. 15-18 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141A. 140 p.
(This summary presents the effects of competing vegetation on jack pine and black spruce diameter growth after 4 years. The study was blocked on 3 major soil types: clay, loam and sand. Competing species were planted at 6 planting densities randomly assigned to the 6 plots in each block. For each planting density, mean basal diameter of jack pine and black spruce were calculated for plots with woody plants, and herbs/shrubs, respectively. The mean relative diameter in the plots with herbs/shrubs is significantly smaller than in the plots with woody plants. Reduced basal diameter can be directly related to the competitive pressure as measured by percent cover.)

Ter-Mikaelian, M.T., R.G. Wagner, F.W. Bell and (C. Shropshire). 1998.
Is PAR better than cover for predicting growth of jack pine seedlings?
Pp. 329-331 *in* Third International Conference on Forest Vegetation Management: Popular Summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(We test whether predictions of jack pine growth based on vegetation cover can be improved using a single set of PAR measurements, or multiple measurements of PAR taken throughout the growing season. Two types of PAR measurements were taken: (1) single measurements across all planting densities of each competing species at the point of maximum leaf area; and (2) seasonal measurements taken in the high density plots of each species througout the season. If predicting the effects of competition is the primary aim, no gain was achieved using both single and seasonal PAR measurements. This result, however, does not preclude the use of PAR for other purposes, such as quantifying physiological responses. Although not tested, our inability to increase prediction with seasonal PAR measurements over a single point measurement at maximum leaf area suggests that single estimates of percent cover produce models equal to those using season-long measurements.)

(Thevathasan, N.V.), (P.E. Reynolds), (R. Kuessner) and F.W. Bell. 1998.

Effects of controlled weed densities and soil types on soil nitrate accumulation, spruce growth, and weed growth.

Pp. 332-334 *in* Third International Conference on Forest Vegetation Management: Popular Summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p. (Objectives of this study were (1) to quantify soil nitrate (NO_3) accumulation rates at varying weed densities established on 3 soil types (clay, loam, sand); (2) to assess the effects of carbon:nitrogen (C:N) ratio, soil-related parameters, and vegetation characteristics on NO_3 accumulation rates; and (3) to assess the effects of soil NO_3 levels on weed and black spruce seedling growth. We conclude that NO_3 accumulation rates are influenced by soil type, soil parameters, and C:N ratio. This study suggests that the latter may be used as an indicator to predict nitrogen release patterns. Weed control by itself may not improve spruce growth. Weed control strategies need to be site specific. Cultivation of alder as nurse crop on low fertility soils to improve nitrogen nutrition, and spruce growth, should be considered. Soil NO_3 accumulation has benefitted cultivated weeds, and not improved spruce growth. In most cases, improved spruce growth is dependent upon weed control. Finally, weeds must be controlled for seedlings to benefit nutritionally.)

(Thompson, D.G.), (D.P. Kreutzweiser), (S.B. Holmes) and R.A. Lautenschlager. 1998.

Introduction to the ecological effects field tour.

Pp. 63-66 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141A. 140 p.

(During the field tour, the focus will be on a variety of environmental research initiatives undertaken by the Canadian Forest Service and the Ontario Ministry of Natural Resources, which address environmental protection, wildlife habitat, and ecosystem effects issues. Any anthropogenic activity, including harvesting and all vegetation management practices, has the potential for deleterious ecosystem effects. Research and resultant empirical evidence is an essential element in the continued evolution to more holistic, ecosystem-level management policies and practices, which minimize or mitigate against such risks. While there are specific case exceptions, research conducted to date suggests that vegetation management activities typically do not generate significant, massive, or long-term deleterious impacts in constituent terrestrial or aquatic elements of forest ecosystems as commonly perceived by the general public. The ecological structure and function of forest ponds and streams are closely linked to the surrounding terrestrial environment and driven largely by inputs therefrom. Alterations to riparian and upland vegetation can have major impacts on the biogeochemical properties and biotic communities of streams and shoreline areas. These impacts include increases in water temperature, changes in nutrient inputs, altered organic matter dynamics and in-stream processes, and increased erosion and sediment loading, with associated changes in aquatic biodiversity.)

Wagner, R.G. and (D.G. Thompson). (comp.). 1998.

Third International Conference on Forest Vegetation Management: Popular summaries.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(Following the success of the previous international conferences (Auburn, Alabama, USA, 1992; Rotorua, New Zealand, 1995), this third conference focussed on (1) alternative methods of vegetation control, (2) ecosystem effects associated with vegetation management practices, and (3) ecosystem management and its implications for forest vegetation management. This document includes 129, 3-page popular summaries for the oral and 48 for the poster presentations at the Third International Forest Vegetation Management

Conference held in Sault Ste. Marie, Ontario, Canada from August 24-28, 1998. *(Out of print.)*)

Wagner, R.G., (J. Flynn) and (R. Gregory). 1998.
Public perceptions of risk and acceptability of forest vegetation management alternatives in Ontario.
For. Chron. 74(5): 720-727.
(We examined public perceptions of risk and acceptability for 9 alternatives to controlling forest vegetation in Ontario in 1994. Ranking of alternatives from highest to lowest perceived risk was: aerially applied herbicides > biological control > ground-applied herbicides > mulches > prescribed fire > heavy equipment > cover cropping > manual cutting > grazing animals. Public acceptance was lowest for aerially applied herbicides (18%) followed by ground-applied herbicides (37%), biological control (57%), prescribed fire (57%), mulches (65%), heavy equipment (72%), cover cropping (80%), grazing animals (82%), and manual cutting (89%). Acceptability of biological control agents ranged from 73% for natural plant toxins to 42% for microorganisms, 39% for genetically engineered organisms, and 21% for viruses. There was a strong correlation between risk perception index and acceptability of alternatives for the general public and those in timber-dependent communities. Our results suggest that stronger public support can probably be achieved for forest vegetation management programs that include non-herbicide alternatives.)

Wagner, R.G., (J. Flynn) and (R. Gregory). 1998.
Public perceptions of risk and acceptability of vegetation management alternatives in Ontario.
Pp. 345-347 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.
(The objectives of this study were to (1) quantify the perceived health and environmental risks of forest vegetation management alternatives by the Ontario public, (2) document public acceptability of those alternatives, and (3) examine the relation between perceived risks and public acceptability of the alternatives. Questions about the risks and acceptability of 9 forest vegetation management alternatives were asked as part of a larger telephone-administered questionnaire about other forestry issues that included 140 questions and took 30 to 40 minutes to complete. All data were collected between September and November 1994 by Goldfarb Consultants. Respondents rated the acceptability to each alternative as either very unacceptable, unacceptable, acceptable, or very acceptable. A risk perception index was calculated. We found a strong correlation between the risk perception index and acceptability of the alternatives for the general public. Controlling unwanted vegetation to improve the survival of planted trees was supported by 82% of the general public and 78% of those from timber-dependent communities. Strong public support for forest vegetation management programs, therefore, can likely be achieved through sincere efforts to include non-herbicide alternatives and other practices perceived as environmentally sensitive and restorative.)

Wagner, R.G., (J. Flynn), (R. Gregory), (C.K. Mertz) and (P. Slovic). 1998.
Acceptable practices in Ontario's forests: Differences between the public and forestry professionals.
New For. 16: 139-154.
(Public opposition to forestry practices, especially clearcutting and the use of herbicides, has become a major factor affecting silviculture in North America. Environmental values, agreement with the goals of forest management, perceptions of risk, trust in science and forest managers are dimensions that determine the degree of public acceptability for specific forestry practices. Understanding how the public differs from forest managers in these dimensions can be used to enhance public communications and resolve conflict about forest management plans.)

Wagner, R.G., T.L. Noland and G.H. Mohammed. 1998.

Critical period for herbaceous vegetation control for northern conifer species.

Pp. 45-48 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap.141A. 140 p.

(The objective of this study is to identify and compare the critical-period thresholds of herbaceous vegetation control for black spruce, jack pine, eastern white pine, and red pine during the first 5 years after planting. Ten treatments were used to remove herbaceous vegetation (grasses, ferns, and forbs) in a sequential pattern for the first 5 years after tree planting: no vegetation removal; annual vegetation removal; 1, 2, 3, and 4 years of consecutive removal; and waiting 1, 2, 3, and 4 years before annual removal was initiated. Results indicated that early control of herbaceous vegetation after planting is vital if maximum stem volume growth is a management objective for northern conifers. Losses in stem volume of 70% or more can be expected without control of herbaceous vegetation during the first 5 years after planting. Interspecific competition with herbaceous vegetation appears to be most significant from 1 year after planting and extends for 2 to 4 years depending on the conifer species. Critical periods were longer for shade-tolerant conifer species (black spruce and white pine) than intolerant conifers (jack or red pine), indicating that tolerant conifer species require greater intensity of vegetation management to accelerate early stand growth. Conifer survival and height growth were not reduced substantially by competition from herbaceous vegetation.)

Wagner, R.G., T.L. Noland and G.H. Mohammed. 1998.

Critical-period thresholds for northern Ontario conifers associated with herbaceous vegetation: 5th-year results.

Pp. 348-350 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(The objective of this study is to identify and compare the critical periods of interspecific competition between herbaceous vegetation and black spruce, jack pine, eastern white pine, and red pine during the first 5 years after planting. Ten treatments were used to remove herbaceous vegetation (grasses, ferns, and forbs) in a sequential pattern for the first 5 years after tree planting: no vegetation removal, annual vegetation removal; 1, 2, 3, and 4 years of consecutive removal; and waiting 1, 2, 3, and 4 years before annual removal is initiated. Conifer survival and growth (height, stem diameter, crown width) were measured annually in October for each of the first 5 years of the study. Fifth-year survival was not reduced by herbaceous vegetation for any conifer species. Tree height was variable among treatments, but revealed minor increases for red pine, white pine, and spruce with increasing duration of vegetation control. Black spruce had a critical period of 1, 2, and 3 years. White pine stem volume benefitted more from an increasing duration of control than other species having a linear weed free curve. As a result, white pine had the longest critical period of from 1 to 4 years. Despite different successional roles and shade tolerance ratings for the 4 conifer species (jack pine - very intolerant, red pine - intolerant, white pine - intermediate, black spruce - tolerant), both similarities and differences were found in their responses to the control of herbaceous vegetation. Although absolute stem volume growth decreased with increased shade tolerance, tolerant conifers appear to benefit from early control of herbaceous vegetation at least as much or more than intolerant species, and (for the period studied) appear to have slightly longer critical periods. Remeasurement of these plots in future years will determine whether these patterns continue.)

(Ward, J.L.), (Y.H. Prevost), R.A. Lautenschlager and F.W. Bell. 1998.

Effects of alternative conifer release treatments on epigeal insects, Coleoptera, Carabidae, and non-insectan arthropods in northwestern Ontario.

Pp. 351-353 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(The primary objective of this study, a component of the Fallingsnow Ecosystem Project, was to examine the effects of conifer release alternatives on surface-active insects and non-insectan arthropods. Surface-active insects and non-insectan arthropods were monitored before (1993) and 1 growing season after post-harvest conifer release treatments were applied in a randomized complete block design. Treatments included aerially applied Vision, aerially applied Release, motor-manual release with brushsaws, mechanical release with the Silvana Selective Ford Versatile cleaning machine (Silvana Selective), and control. The conifer release treatments did not significantly alter microhabitats for the majority of arthropods examined. Lower carabid diversity indices in both brushsaw and Silvana Selective treatments, however, may be due to decreased movements by carabids following these treatments, while higher diversity following herbicide treatments may indicate increased movement and trapability due to decreased vegetation cover.)

(Woodcock, J.), (D.G. Pitt), (U. Runesson), F.W. Bell and R.A. Lautenschlager. 1998.

GIS analysis of songbird/vegetation relationships.

Pp. 363-365 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(As part of the Fallingsnow Ecosystem Project, a geographic information system (GIS) was used to analyze breeding songbird use of stand-level habitat in 4 regenerating clearcuts in northwestern Ontario. The objective of this study was to determine associations among vegetation components and birds' spatial use of the clearcuts. There were no significant differences in songbird territory densities among treatments in the pre-treatment year. The presence of a significantly higher proportion of high shrubs inside territories, as compared to outside appears to be the single most important factor in determining the location of territories. The GIS methods used enabled the identification of habitat components significantly affecting the distribution of birds among treated and untreated areas.)

(Woodcock, J.), R.A. Lautenschlager and F.W. Bell. 1998.

The effects of clearcut logging on songbirds relative to the effects of conifer release treatments.

Pp. 95-98 *in* Third International Conference on Forest Vegetation Management: In-conference tour guide. D.G. Pitt and F.W. Bell, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141A. 140 p.

(The objectives of this study were to compare breeding bird populations in 4 tracts of mature boreal mixedwood forest with those in adjacent clearcuts where conifers were experimentally released and discuss results in relation to what might be expected following non-anthropogenic disturbances, such as wildfire or hurricanes. Breeding birds were surveyed using 100-m fixed-radius point counts of 10 minute durations. Five observation stations were located in each stand of mature forest, spaced 200 m apart and a minimum of 100 m from any forest edge. Five visits were made between 05:30 and 11:00 during early, mid-, and late June 1995 and 1996. The numbers of males of each species of bird, detected aurally or visually, were tallied and the mean number of detections in each sample were subjected to statistical analyses. Two years prior to surveying the following conifer release treatments were applied: (1) helicopter-

applied solutions containing the herbicide Vision® (a. i. glyphosate), (2) helicopter-applied solutions containing the herbicide Release® (a.i. triclopyr), (3) manual release with brush saws, (4) mechanical release with Silvana Selective/Ford Versatile tractor, and (5) no treatment. The magnitude of the effect of the logging activities on songbirds relative to the conifer-release treatments is illustrated by the number of species significantly affected. No large changes in species composition were detected as compared to natural disturbances and logging.)

Zakrzewski, W.T. 1998.

Integrating timber surveys with ecological land classification in Ontario: New methods, models, and applications.

Pp. 493-495 *in* Third International Conference on Forest Vegetation Management: Popular summaries. R.G. Wagner and D.G. Thompson, comp. Sault Ste. Marie, ON, 24-28 Aug. 1998. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 141. 508 p.

(The TCM/PAM System is a computerized tool that allows the user to estimate timber volume at the stand or individual tree level. The system consists of a: Plot Assessment and Modelling Guide (PAM) field application program, and Timber Cruising and Modelling compiler (TCM) installed on the PC. This is a description of the tool and what it can be used for.)

Publications 1999

Baldwin, D.J.B., (L.E. Band) and A.H. Perera. 1999.

Assessment of the spatial structure and properties of existing ecoregionalization systems of Ontario.

Pp. 349-356 *in* Spatial Accuracy Assessment: Land Information Uncertainty in Natural Resources. K. Lowell and A. Jaton, eds. Ann Arbor Press,

(This chapter summarizes a thesis that quantified 3 existing regionalization systems in Ontario using spatial surfaces of geoclimatic variables relevant to ecosystem function and composition. The main objective was to quantify strengths and weaknesses of each system in delineating these variables, illustrating phenomena delineated most effectively by each system, at each location. Here we present the techniques developed to quantify and compare ecoregionalization systems and outline conclusions relevant to the development of new ecoregionalization systems.)

(Band, L.E.), (F. Csillag), A.H. Perera and (J.A. Baker). 1999.

Deriving an eco-regional framework for Ontario through large-scale estimates of net primary productivity.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 149. 30 p.

(The Hierarchical Ecological Framework (HEF) project was initiated by the Ontario Ministry of Natural Resources to provide a hierarchical framework for understanding and managing the ecosystems of Ontario. The focus of this study was to estimate the distribution of ecosystem productivity at the provincial scale and to explain the nested patterns of productivity based on geoclimatic variables. This work serves as the first in a series of successively nested investigations into the controls and spatial patterns of forest ecosystem processes. At the largest scales (ecoprovince to ecoregion), geoclimate controls much of the variance in productivity across the province. At progressively smaller spatial scales (ecodistricts), local landforms and soils control productivity. The techniques developed were used to partition Ontario into distinct, ecologically consistent, nested zones. This partitioning framework has certain similarities to and advantages over more commonly used ecological regionalization systems and provides a flexible toolbox with many potential applications.)

Bell, F.W., (D.G. Pitt), (A.E. Morneault) and (S.M. Pickering). 1999.

Response of immature trembling aspen to season and height of cut.

N. J. Appl. For. 16(2): 108-114.

(Effects of season and height of cutting to control the regrowth of young trembling aspen were studied on 4 sites in Ontario. Aspen stems, averaging 1.5 to 3.2 m in height, were cut in fall (October 1993), winter (February/March 1994), and summer (June/July 1994) at 10, 25, 50, 75, or 100 cm above ground level.

Density and height of new root suckers; number, point of origin, and growth of stem sprouts; and tissue mortality in cut stems were evaluated by analyses of variance with linear contrasts to determine the effects of cutting height, season of cutting, and their interactions. Two years of post-treatment data indicate that aspen regeneration may be reduced if manual cutting occurs in June/July, at a cutting height of 50 to 75 cm. This timing and cutting height provides maximum stem mortality with minimum sprouts per stem and minimum sucker regeneration. If aspen regeneration is the goal, cut in the fall at 25 cm for maximum regrowth.)

Bell, F.W. and R.A. Lautenschlager. 1999.
The Fallingsnow Ecosystem project: An environmental assessment of alternative conifer release treatments.
Pp. 64-66 *in* NIVMA Annual General Meeting, Edmonton, AB, 11-12 March 1999. NIVMA.
(The Fallingsnow Ecosystem Project, located near Thunder Bay, Ontario, is an integrated, multi-disciplinary study established in 1993 to evaluate the effects of 5 alternative conifer release treatments on a number of environmental components in young spruce plantations. Researchers are working together to document and compare the effects of alternative conifer release treatments on soil nutrients, near-ground microclimate, vegetation, and wildlife. The project, a randomized complete block design, with 4 blocks, is located 60 km southwest of Thunder Bay, ON. Treatments, applied in 1993, were cut with brushsaws in October; cut with a Silvana Selective/ Ford Versatile in October; Release® herbicide applied by helicopter in August; Vision® herbicide applied by helicopter in August; and untreated "control". In addition, the unharvested forests adjacent to each block were monitored. Results are discussed.)

Bell, F.W. and W.C. Parker. 1999.
Silvicultural and ecophysiological aspects of vegetation management for regeneration of white pine.
Pp. 1-4 *in* Your Forest - Your Choice Conference. 27-28 Sept. 1999. Westwind Forest Stewardship Inc.
(Successful regeneration of white pine is dependent in part on consideration of competitive species and application of appropriate silvicultural prescriptions. On ecosite 11.2 of central Ontario, balsam fir, beaked hazel, and bracken fern are major competitors for white pine. While silvicultural prescriptions for management of these species are being developed and improved, knowledge of thresholds for white pine under competition with these species singly, or in combination, can be used to further improve the timing and efficiency with which vegetation management treatments are applied. Moreover, an understanding of competition effects on white pine ecophysiology will enable us to refine silvicultural prescriptions for white pine regeneration.)

Buse, L.J. 1999.
Adaptive management successes showcased at Science Forum.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 4(1): 3.

(This article summarizes the 1998 Science Forum on Adaptive Management report, *Sci. Devel. Transf. Ser. 001*, which provides examples of how adaptive resource management has been used in other jurisdictions, summarizes bridges and barriers to using it more widely in Ontario, and suggests some high-priority resource management issues to which MNR can begin to apply an adaptive approach.

Cole, W.G., (E.C. Mallory) and (D.N. Niblett). 1999.
Swan Lake Forest Research Reserve - Annotated bibliography 1955-1999.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 144. 57 p.
(The Swan Lake Forest Research Reserve is a 2,000 ha experimental forest established in 1950 in Algonquin Provincial Park. This annotated bibliography contains references and abstracts for more than 250 papers, reports, and other technology transfer products that were produced, in whole or in part, as a result of research that has occurred at the reserve.)

Colombo, S. 1999.

Physical and physiological changes in spruce seedlings during hardening.

In Forest Nursery/Silvicultural Practices Technology Course Module VIII. Edmonton, AB, 13-14 Dec. 1999. Can. For. Serv; Alberta For. Nurs. Assoc., 11 p.

(This paper provides background information on bud initiation and needle and stem development in spruce seedlings in relation to hardening. Nursery crop management and stock quality are also discussed.)

Colombo, S.J. and W.C. Parker. 1999.

Does Canadian forestry need physiology research?

For. Chron. 75(4): 667-674.

(This paper emphasizes the need for physiology research at various scales in support of intensive forest management. Examples of recent contributions of physiology to Canadian forestry are provided and current needs summarized. Future potential contributions of physiology research in the areas of intensive forest management, conservation of biological diversity, forest ecosystem condition and productivity, and the global carbon cycle are outlined.)

(Duchesne, L.C.), R.A. Lautenschlager and F.W. Bell. 1999.

Effects of clearcutting and plant competition control methods on carabid (Coleoptera: Carabidae) assemblages in northwestern Ontario.

Environ. Monit. Assess. 56: 87-96.

(Total captures, species richness, diversity, and assemblages of adult carabids in a boreal mixedwood ecosystem study were compared among unharvested and clearcut plots, untreated or treated with herbicides (Vision and Release), or mechanical treatments (brush saw and Silvana Selective). Carabids were sampled using unbaited pitfall traps for 1 growing season, 7 and 9 years after clearcutting, in the second growing season after competition control. A total of 5032 individuals representing 30 species were collected between June 1 and September 25, 1995. Total catches were not affected by the harvest or conifer release alternatives. Ten species showed habitat preferences after treatment. The remaining species were not affected.)

(Fleming, R.A.), (D.B. Lyons) and J.-N. Candau. 1999.

Spatial transmutation and its consequences in spatially upscaling models of spruce budworm population dynamics.

Can. J. Remote Sens. 25(4): 388-402.

(The effects of spatial transmutation on model development and interpretation of model output are considered in the context of 2 models for spruce budworm population dynamics — a detailed simulation model and an autoregressive time series model. Previous results pertaining to the detailed simulation model are compared with analyses of spatial transmutation in the time series model. In general, the greater ratio of spatial scales and the greater the regional spruce budworm densities, the more pronounced the spatial transmutation. Parameter estimation is also scale dependent, and consequently even the qualitative nature of the underlying dynamics can appear to change in response to scaling up. This makes it necessary to consider spatial transmutation when combining data measured at different spatial resolutions during model development and when comparing time series of population data taken at different spatial resolutions. Identifying a natural, biologically defined scale, developing a correction factor, and incorporating covariance relationships are 3 possible approaches to countering the effects of spatial transmutation. We examined spatial heterogeneity in spruce budworm densities for changes over time. In survey data from New Brunswick, populations of second instar larvae were spatially aggregated throughout the declining phase of the latest outbreak cycle, but became less so as densities decreased. Variogram analysis showed that the mean distance within which spatial correlation occurred decreased from about 120 km at high spruce budworm densities to about 20 km at low densities.)

(Guyette, R.P.) and W.G. Cole. 1999.

Age characteristics of coarse woody debris (*Pinus strobus*) in a lake littoral zone.

Can. J. Fish. Aquatics Sci. 56(3): 496-505.

(Littoral coarse woody debris (CWD) is a persistent class of aquatic habitat that accumulates over many centuries and provides habitat for diverse floral and

faunal communities. We used dendrochronological methods to analyze residence times and age-related characteristics of eastern white pine CWD in the littoral zone of Swan Lake in Algonquin Provincial Park, Ontario. Annual rings dated from calendar year 1893 to 982. The mean time from carbon assimilation in a live tree to carbon loss from littoral woody debris was 443 years. Outside rings dates of the woody debris were significantly correlated with the bole's maximum and minimum diameter ratio, mass, specific gravity, length, and submergence. Accelerated inputs of woody debris resulted from late nineteenth century logging and a disturbance circa 1500. No mature eastern white pine have fallen into the lake over the last 100 years.)

Hayden, J., (E. Boysen), (M. Woods) and J. Rice. 1999.
Making cents out of forest inventories: A guide for small woodlot owners.
Ont. Min. Nat. Resour., Sault Ste. Marie, ON., Sci. Devel. Transf. Ser. No. 002. 32 p. + append.
(This booklet outlines the type of inventory information you need to manage your woodlot, and suggests where and how you might collect it. The basic skills of timber cruising and compiling data are discussed, and "do-it-yourself" information is provided where appropriate.) *(Order from the Natural Resources Information Centre at 1-800-667-1940 for $9.99)*

(Jiang, H.), C.H. Peng, (M.J. Apps), (Y. Zhang), (P.M. Woodard) and (Z. Wang). 1999.
Modelling the net primary productivity of temperate forest ecosystems in China with a GAP model.
Ecol. Model. 122: 225-238.
(The dynamics of net primary productivity (NPP) and biomass of temperate forests in northeastern China were examined by comparing field data with simulation results from the ZELIG model. For broadleaf/ Korean pine mixed forests, biomass was estimated between 198 and 370 Mg ha^{-1} and NPP was estimated at 8 to 20 Mg ha^{-1} year^{-1}. Simulation results indicate that NPP in mixed forests would discontinuously increase over the next 200 to 400 years, to a maximum value of 21 Mg ha^{-1} year^{-1}; while biomass would peak in about 300 years at 400 Mg ha^{-1} year^{-1}, and then slowly decline. For oak forests, simulated NPP ranges from 5 to 13 Mg ha^{-1} year^{-1}, with biomass estimated at 120 to 310 Mg ha^{-1} year^{-1}. In aspen-birch forests, maximum NPP and biomass values were 7 and 50 Mg ha^{-1} year^{-1}, respectively. Larch forests were found to have lower values of NPP and biomass than other forest types, with NPP between 5 and 12 Mg ha^{-1} year^{-1}, and biomass between 50 and 275 Mg ha^{-1} year^{-1}. Comparison of measured field data with ZELIG simulated values indicates only an 8 to 13% error, based on more than 50 independent plots, with a mean accuracy for simulated NPP between 88 and 93%.)

(Jiang, H.), (M. J. Apps) and C.H. Peng. 1999.
Modelling the effects of fire disturbances on the carbon dynamics of boreal forests in central Canada.
Pp. 393-404 *in* The Sustainable Forest Management Network Conference–Science and Practice: Sustaining the Boreal Forest. T.S. Veeman, D.W. Smith, B.G. Purdy, F.J. Salkie and G.A. Larkin, eds. Edmonton, AB, 14-17 Feb. 1999. Sustainable For. Mgmt. Network.
(CENTURY 4.0, an ecosystem-based process simulation model, was used to simulate the dynamics of biomass, litter, soil organic matter, and soil carbon, on the estimated carbon budget in central Canadian boreal forests. The results of the simulations show that fire disturbances influence the allocation of carbon in boreal forests. As biomass is burned, carbon is released, increasing the source of carbon in boreal forests. The strongest influence on carbon dynamics occurred under uniform, short fire return intervals.)

(Jiang, H.), (M.J. Apps), (Y.L. Zhang), C.H. Peng and (P. Woodard). 1999.
Modelling the spatial pattern of net primary productivity in Chinese forests.
Ecol. Model. 122: 275-288.
(The spatial patterns of biomass and net primary productivity in China's forests were estimated using empirical data sets, remote sensing methods, and

climate-vegetation models, and were analyzed within a spatial analysis system. Differences between spatial modelling methods for estimating net primary production (NPP) were also examined and compared. Present spatial patterns of NPP in Chinese forests are the result of both natural environmental factors and human land use patterns. Estimates of NPP for the tropical zone were highest, ranging from 20 to 24 Mg ha^{-1} $year^{-1}$, while those in the boreal were lowest, averaging only 6.7 Mg ha^{-1} $year^{-1}$. Results reported here demonstrate the usefulness of spatial analysis techniques for improving the accuracy of NPP estimates and our understanding of NPP spatial patterns and dynamics in forest ecosystems.)

(Kim, Y.T.), S.J. Colombo, D.F. Hickie and T.L. Noland. 1999.

Amino acid, carbohydrate, glutathione, mineral nutrient and water potential changes in non-water-stressed *Picea mariana* seedlings after transplanting.

Scand. J. For. Res. 14: 416-424.

(Monthly changes in amino acids, carbohydrates, glutathione, and minerals in needles and roots, and the growth of transplanted and non-transplanted black spruce seedlings during 1 growing season were compared. Seedlings were watered throughout the growing season. Shoot water potential did not differ significantly between control and transplanted seedlings. Compared with control seedlings, needles of transplanted seedlings had significantly lower levels of all macronutrients and some micronutrients, certain individual and total amino acids, and sucrose. Needles of transplanted seedlings haed higher concentrations of tryptophan and certain carbohydrates. Total amino acid content of the needles may be useful as a biochemical indicator of transplant shock in non-water-stressed black spruce seedlings.)

Lautenschlager, R.A. 1999.

Environmental resource interactions affect red raspberry growth and its competition with white spruce.

Can. J. For. Res. 29:906-916.

(Multifactor experiments were used to study the effects of (1) shade, moisture, and nutrients on above- and belowground biomass production of red raspberry and (2) intra- versus interspecific competition for light, nitrogen, and space in interplantings of raspberry and white spruce seedlings. Interactive effects on seedling growth were common. Raspberry biomass increased with increasing moisture and nutrients. Seventy-three percent shade reduced raspberry biomass production, while production under full sun and 30% shade was similar. Raspberry shoot/root ratio increased with increasing nutrients and shade but decreased with age. In mixed plantings with spruce, when nitrogen was added, raspberry biomass and shoot/root ratio increased at the expense of spruce, while the shoot/root ratio decreased with shade in low-nitrogen plots. Spruce height growth was not affected by light level, nitrogen addition or competition type; however, spruce diameter and biomass production decreased with competition from both raspberry and spruce and increased with increasing growing space and in low-nitrogen shaded plots where raspberry was less common.)

Lautenschlager, R.A. 1999.

Improving long-term forest ecology research for the 21st century.

For. Chron. 75(3): 477-480.

(Changes in scientific views, approaches, and the public's environmental concerns have broadened the foci of silvicultural research from individuals in stands to these plus other interacting components at broader temporal and spatial scales. Present studies have benefited from increasing interdisciplinary ecological study; however, even the most interdisciplinary research and management could be improved by (1) moving beyond public comment to incorporating the public's environmental concerns into experimental and management designs; (2) being conducted at scales (time and space) that are appropriate to ecosystem components of greatest concern; (3) encouraging researchers and managers to test their knowledge using landscape-level forest vegetation management and checking predictions using sufficent monitoring; and (4) recognizing that within-study integration will require identifying study-appropriate integrative currencies.)

Lautenschlager, R.A. 1999.
Intensive silviculture — part of Ontario's new *Living Legacy*.
For. Chron. 74(3): 535.
(Opinion piece about what intensive silviculture is and what it may mean to forestry.)

Lautenschlager, R.A. and (C. Nielson). 1999.
Ontario's forest science efforts following the 1998 ice storm.
For. Chron. 75(4): 633-641.
(The 1998 ice storm, which caused extensive damage to forests from eastern Ontario to the Canadian Maritimes, led to a variety of economic and ecological questions from governments, concerned publics, and stakeholder groups. Here we outline how the Ontario Ministry of Natural Resources, working with other organizations, developed short- and longer-term responses to those questions. Efforts have already produced: (1) a low-level aerial survey of forests damaged; (2) extension notes for homeowners, landowners, maple syrup producers, plantation owners, natural resource agencies, and municipalities; (3) information for media and natural resources education groups; (4) standardized techniques and training for assessing damage and making recommendations; (5) literature reviews; and (6) management guidelines. A manipulative experiment in sugar maple stands has been initiated to document: (1) the effects of tapping on sugar maple recovery; (2) the potential of remedical treatments to speed recovery or mitigate further damage; and (3) the effects of both damage and potential remedial treatments on sap production; and (4) selected ecological consequences of damage and remedial treatments. Research to examine the effects of damage to woodlots and plantations will: (1) quantify damage in plots representing a variety of forest types; (2) examine disease, stain, decay, and insect damage probabilities in broadleaf and conifer stands; (3) document insect responses to damage in red pine plantations; (4) develop economically based decision-support tools for damaged pine and maple stands; and (5) document the biological and economic consequences of post-damage salvage and clean-up operations.)

Lautenschlager, R.A., (W.J. Dalton), M.L. Cherry and (J.L. Graham). 1999.
Conifer release alternatives increase aspen forage quality in northwestern Ontario.
J. Wildl. Manage. 63(4): 1320-1326.
(Conifer release reduces browse availability and moose use of treated areas for up to 4 years posttreatment; however, it has been unclear how release affects forage quality. We determined percent digestible dry matter (DDM) and percent digestible protein (DP) of trembling aspen, beaked hazel, and red raspberry collected during mid-July, 2 growing seasons after the following operational treatments were applied: Vision herbicide, Release herbicide, cutting (brush saw, Silvana selective) and no treatment. Only trembling aspen, which had the highest DDM and DP, showed differences among treatments. Aspen DDM was 5-11% and DP was 34-49% greater on released plots. Although not statistically significant, DP was consistently higher for hazel and raspberry on herbicide-released plots. Biomass availability of forage species continues to be a realistic way to predict the effects of conifer-release treatments on ungulate forage.)

MacDonald, G.B., (J. Fraser) and (P. Gray). (eds.). 1999.
Adaptive management forum: Linking management and science to achieve ecological sustainability.
Ont. Min. Nat. Resour., Sault Ste. Marie, ON, Sci. Devel. Transf. Ser. No. 001. 58 p.
(This 4-day forum brought together 108 participants from a variety of disciplines and jurisdictions in North America to share knowledge and experiences that could facilitate the broader application of adaptive management in Ontario. This report documents the major components of the forum, summarizes the barriers and bridges to adaptive management in Ontario identified at the forum, presents key recommendations of participants, and concludes with comments from

the Deputy Minister. The report is intended to help facilitate increased understanding and application of adaptive management by Ontario's resource management agencies, while minimizing the potential pitfalls.)

Mohammed, G.H. 1999.

Non-timber forest products in Ontario: An overview.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Inf. Pap. No. 145. 64 p.

(Non-timber forest products (NFTPs) are botancial products harvested or originating from forest-based species. This report reviews commercial and noncommercial NTFPs, issues associated with NTFP use and development, and recommendations for sustainable development of the sector. Information from other jurisdictions is provided where relevant to Ontario. Non-timber forest products are categorized as foods, health, and personal care products; environmental products; landscape and garden products; and decorative and aesthetic products. About 50 types of products – such as nuts, essential oils, specialty wood products, dyes, mulches, and biofuels – were identified. Issues relevant to the NFTP sector include sustainability of wild plants, health and safety aspects, and social and economic factors. Recommendations for strengthening the non-timber product industry in Ontario while respecting the need for sound ecological stewardship are provided. There is need for greater emphasis on value-added rather than bulk products, utilization of waste materials, coordination of collection with timber harvest and tending operations, emphasis on rural and community-based opportunities, and cultivation of target species.)

Mohammed, G.H. and W.C. Parker. 1999.

Photosynthetic acclimation in eastern hemlock [*Tsuga canadensis* (L.) Carr.] seedlings following transfer of shade-grown seedlings to high light.

Trees 13: 117-124.

(We studied photosynthetic acclimation of eastern hemlock seedlings in the first month after sudden exposure of shade-grown seedlings to full sunlight. In a greenhouse experiment, seedlings were grown under full sun or 80% shade, and after 7 months, a sample of the shaded trees were transferred to full sun in the greenhouse. Photosynthetic responses of shaded, transferred, and sun trees were followed over the course of 26 days to track short- to medium-term acclimation responses. Pre-existing foliage of transferred plants had a prolonged reduction in the ratio of variable to maximal fluorescence, and a limited capacity to adjust photochemical quenching or photosystem II quantum yield in the light to increasing light intensity compared to sun foliage, and apparently had some difficulty sustaining non-photochemical quenching. Seedling survival was only 58% among transferred seedlings, compared to 80% and 100% in the shade or sun groups, respectively. Photosystem II quantum yield in the light, and photochemical and non-photochemical quenching were similar between newly formed foliage of transferred and sun plants. These findings indicate that eastern hemlock depends strongly on the production of new foliage for photosynthetic adjustments to high light, and that development of photosynthetic competence may be a gradual process that occurs over successive foliar production cycles.)

Newmaster, S.G., F.W. Bell and (D.H. Vitt). 1999.

The effects of glyphosate and triclopyr on common bryophytes and lichens in northwestern Ontario.

Can. J. For. Res. 29: 1101-1111.

(The effects of 2 silvicultural herbicides (Vision, Release) on bryophytes and lichens were studied in a harvested boreal mixedwood ecosystem. A completely randomized design with 115 plots of 1 m^2 allowed direct comparison between the herbicides and their effects on community dynamics. Results showed that bryophyte and lichen abundance and species richness decreased after herbicide treatments. In general, herbicide applications reduced the diversity of forest mesophytes and weedy colonizers to an ecosystem with only a few species of colonizers. A combination of clustering techniques and ANOVA were used to divide bryophytes and lichens into 3 ecologically defined response groups:

herbicide-tolerant colonizers, semi-tolerant long-term stayers from dry open forest, and sensitive forest mesophytes.)

Noland, T.L., G.H. Mohammed and N.H. Seymour. 1999.
Using the fluorescein diacetate staining method to estimate seed viability of jack pine, black spruce, and white spruce.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Note No. 58. 4 p.
(Fluorescein diacetate has been shown to have potential as a viability stain for tree seeds. Although results were encouraging, the original FDA procedure did not stain all tissues of the embryo consistently in all tree seed species tested. Also, FDA ratings tended to be lower than germination rates produced by standard germination tests. We have refined the method to produce FDA ratings that closely approximate percent germination in jack pine, black spruce, and white spruce. This note describes how to perform the improved FDA test.)

Obenchain, A.M. 1999.
Assessing the effects of Ice Storm '98 on eastern Ontario forests.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 4(1): 4-5.
(This article highlights what researchers are studying following the 1998 ice storm. Researchers from MNR, CFS, the Eastern Ontario Model Forest, and universities began to develop an ice damage science program in 1998 that includes review of existing scientific literature and expert opinion on post-damage management of woodlots and plantations, investigations on the ice storm and attempts to remediate the damage to sugar maple health and syrup production, and the storm's ecological and economic effects on stands used for timber production.)

Obenchain, A.M. (ed.). 1999.
Insights.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. 4(1): 8 p.
(This issue of OFRI's newsletter highlights the development of a pill tackling blister rust, a science forum on adaptive management work, assessing the effects of ice damage on trees, and a new test for checking seedling condition.)

Obenchain, A.M. 1999.
Pill shows promise in fighting white pine blister rust.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 4(1): 1-2.
(Researchers are nearly done testing a pill that could greatly improve survival and growth of eastern white pine regeneration. The pill under study contains a fungicide, an insecticide, and a fertilizer and is placed in the planting hole under the seedling. The young tree slowly absorbs the contents of the pill, which help it to resist white pine blister rust and white pine weevil and to grow more quickly. The data so far indicate that this pill helps keep white pine growing strong until at least age 5, when we can start to manage blister rust through other means, such as pruning lower branches. The fertilizer helps reduce the time until the crowns start to touch, which changes the microclimate, reducing moisture levels in the tree and discouraging blister rust from establishing. This pill may be one practical tool for sustaining this highly valued species.)

Obenchain, A.M. 1999.
Stock quality assessment update: New seedling test could enhance reforestation success.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Insights 4(1): 6.
(Researchers with OFRI's Stock Quality Assessment Program are developing a new procedure for evaluating the condition of tree seedlings. The new test assesses *cuticular transpiration (CT)*, or the rate of water loss from needles. Seedlings with lower CT have needles with more developed cuticles as well as thicker layers of wax, which may help them retain water and avoid moisture stress. The cuticular transpiration test, now commercially available on request from Mikro-Tek Labs in Timmins, is the latest in an array of seedling-assessment tools

developed by OFRI over the last 7 years for the provincial Stock Quality Assessment Program. The other tests: visual damage assessment, chlorophyll fluorescence, root-growth potential, and stress-induced volatile emissions.)

Peng, C.H. 1999.

Nonlinear height-diameter models for nine boreal forest tree species in Ontario.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 155. 28 p.

(Twenty-five nonlinear height-diameter models were fitted and developed for 9 forest species in Ontario's boreal forests based on individual tree height and diameter data collected from permanent sample plots (PSPs) across northern Ontario. Comparison of mean square error and R^2 values show that most concave downward and sigmoidal equations capture the height-diameter relationships for Ontario tree species. Validation of 6 selected models using independent data sets suggests that sigmoidal equations such as the Chapman-Richards, Weibull-type, and Schnute equations provide the best height predictions. However, using these models to extrapolate beyond the range of available data may increase the error margin for large trees.)

Peng, C.H., (H. Jiang) and (M.J. Apps). 1999.

Simulating effects of climate change on structure and function of boreal forest ecosystems in central Canada.

Pp. 405-412 *in* The Sustainable Forest Management Network Conference–Science and Practice: Sustaining the Boreal Forest. T.S. Veeman, D.W. Smith, B.G. Purdy, F.J. Salkie and G.A. Larkin, eds. Edmonton, AB, 14-17 Feb. 1999. Sustainable For. Mgmt. Network

(Possible effects of future climate change on vegetation dynamics and carbon cycling of the boreal forest in the area of the Boreal Forest Transect Case Study in central Canada were investigated using a modified version of the FORSKA 2.0 forest succession model and the process-based plant-soil model CENTURY 4.0. The results presented suggest that, across the transect, climate change would result in changes not only in forest species composition, but also in increased net primary productivity and total carbon in vegetation biomass but decreased overall carbon in soil. The simulations indicate that the northern sites are more sensitive to climate change than the southern sites.)

Peng, C.H. and (M.J. Apps). 1999.

Modelling the response of net primary productivity (NPP) of boreal forest ecosystems to changes in climate and fire disturbance regimes.

Ecol. Model. 122:175-193.

(This study reports on the use of the process-based ecosystem model CENTURY 4.0 to investigate the patterns of net primary productivity (NPP) along a transect across the boreal forests of central Canada and the influence of climate change, CO_2 fertilization, and changing fire disturbance regimes on changes in NPP over time. Simulated NPP was tested against observed NPP data from northern sites near Thompson, Manitoba, and southern sites near Prince Albert, Saskatchewan. Temporal dynamics of NPP were very different for the southern, central, and northern sites, consistent with the hypothesis that different climate-driven processes regulate forest growth in the various regions of the boreal forest transect case study (BFTCS). Simulations suggest that climate change would result in increased NPP for most sites across the transect. Increases in atmospheric CO_2 also increase NPP. Changes in NPP are positively correlated with changes in net N mineralization. This supports the conclusion that feedback via N cycling, a coupling of aboveground production with changes in belowground decomposition, is very important for understanding the NPP dynamics of the boreal forest under a changing climate. NPP also increases with greater fire frequency under current climate conditions, at least over the range of fire return intervals (50-200 years) considered.)

Peng, C.H. and (X. Wen). 1999.

Recent applications of artificial neural networks in forest resource management: An overview.

In U. Cortes and M. Sanchez-Marre, co-chairs, Environmental Decision-Support Systems and

Artificial Intelligence. AAAI Press, Tech. Rep. WS-99-07. 8 p.
(Making good decisions for adaptive forest management has become increasingly difficult. New artificial intelligence technology allows knowledge processing to be included in decision support tools. Current artificial neural network applications include: forest-land mapping and classification, forest growth and dynamics modelling, spatial data analysis and modelling, plant disease dynamics modelling, and climate change research. The advantages and disadvantages of using artificial neural networks are discussed. Although at an early developmental stage, artificial neural networks have demonstrated potential as a useful tool for forest resource management decision-making.)

(Pitt, D.G.), (C.S. Krishka), F.W. Bell and (A. Lehela). 1999.
Five-year performance of three conifer stock types on fine sandy loam soils treated with hexazinone.
N. J. Appl. For. 16(2): 72-81.
(In May 1987, hexazinone (Velpar® L) was applied by helicopter at 0, 1, 2, and 4 kg active ingredient per ha to a sandy loam site northwest of Thunder Bay, Ontario. Container (FH408 paper pot) jack pine and container and bareroot (1½ + 1½) black spruce were hot-planted 1 month and deferred-planted 12 months after herbicide application. Jack pine container stock planted 1 month after hexazinone treatment at 2 and 4 kg a.i./ha suffered 12% greater mortality than trees planted 1 year later. However, the benefits of early establishment and herbaceous weed control offset these early losses and hot-planted areas supported equal volumes at age 4, and 2.3-fold more volume per ha than deferred-planted areas 5 growing seasons after herbicide treatment. Black spruce container and bareroot stock exhibited high tolerance to hexazinone throughout the range of rates tested. Overall, a 1 year delay in planting resulted in stem and stand volumes that were less than half of those observed in hot-planted areas. Growth response was positively related to the level of herbaceous weed control achieved, with 4 kg treated areas supporting volumes 2- to 4-fold greater than those on untreated areas.)

(Prezio, J.R.), (M.W. Lankester), R.A. Lautenschlager and F.W. Bell. 1999.
Effects of alternative conifer release treatments on terrestrial gastropods in regenerating spruce plantations.
Can. J. For. Res. 29:1141-1148.
(This study examined changes in terrestrial gastropod density and species composition in the second and third year after application of conifer release treatments in regenerating spruce plantations. Data were collected monthly from June to September during 1995 and 1996 from 4 conifer release treatments: herbicides Vision and Release, motor-manual clearing with brush saws, mechanical clearing with Silvana Selective, and untreated controls on 4 replicate blocks. A total of 15,083 terrestrial gastropods, comprising 18 genera and 21 species, was collected using cardboard sheets over the 2 years. Gastropod densities in untreated control areas were 50-60% greater than those in treated areas. The greatest differences in densities among individual treatments were evident in the third summer following treatments. Gastropod densities in cutting treatments recovered more quickly than those in herbicide-treated areas.)

(Price, D.T.), C.H. Peng, (M.J. Apps) and (D. Halliwell). 1999.
Simulating effects of climate change on boreal ecosystem carbon pools in central Canada.
J. Biogeogr. 26: 1237-1248.
(Possible effects of current and future climates on boreal vegetation dynamics and carbon (C) cycling were investigated using the CENTURY 4.0 soil process model and a modified version of the FORSKA2 forest patch model. Eleven climate station locations distributed along a transect across the boreal zone of central Canada. Both models were driven by detrended long-term monthly climate data. Using a climate change signal derived from the GISS general circulation model

equibilibrium climate scenario, the output from both models was used to compare simulated current and possible future total ecosystem C storage at the climate station locations. After allowing for their different underlying structures, comparison of output from both models showed good agreement with local field data under current climate conditions. CENTURY 4.0 was able to reproduce spatial variation in soil and litter C densities satisfactorily but tended to overestimate biomass productivity. FORSKA2 reproduced aboveground biomass productivity and spatially averaged biomass densities relatively well. Under the GISS 2 x CO_2 scenario, both models generally predicted small increases in aboveground biomass C density for forest and tundra locations, but CENTURY 4.0 predicted greater decreases in soil and litter pools, for overall decreases in ecosystem C storage in the range 16-19%.)

(Price, D.T.), (D. Halliwell), (J.M. Apps) and C.H. Peng. 1999.

Adapting a patch model to simulate the sensitivity of central-Canadian boreal ecosystems to climate variability.

J. Biogeogr. 26: 1101-1114.

(The aim of the study was to investigate the effects of within-season and interannual climate variability on the behaviour of boreal forest ecosystems as simulated by the FORSKA2 patch model. Eleven climate station locations distributed along a transect across the boreal zone of central Canada were utilized. FORSKA2's water balance submodel was modified to enable it to behave more realistically under a varying climate. Long-term actual monthly time-series of temperature and precipitation data were detrended and used to drive the modified model. Long-term monthly averages of the same detrended data were used to drive the unmodified model. Results indicated that the modifications significantly improved species composition simulations at sites in boreal Canada. Simulated forest biomass values were slightly higher than those obtained from the unmodified model using averaged climate records, but resembled the observed distribution of vegetation more closely. Modified FORSKA2 suggests that boreal forest composition and distribution may be more sensitive to changes in monthly rainfall data than to changes in temperature. Climate variability affects seasonal water balances and should be considered when using path models to forecast vegetation dynamics during and following a period of climate transition. The modified model provided improved representation of the latitudinal trend in spatially averaged biomass density in this region.)

(Sullivan, T.P.), R.A. Lautenschlager and (R.G. Wagner). 1999.

Clearcutting and burning of northern spruce-fir forests: Implications for small mammal communities.

J. Appl. Ecol. 36:327-344.

(This study was designed to test the hypothesis that abundance and related demographic parameters of small mammal populations would decline after clearcutting of northern spruce-fir forest, and prescribed burning following clearcutting, an approach to emulating natural disturbance, would enhance the species richness and diversity of the small mammal community relative to unharvested and clearcut forests. Intensive live-trapping of small mammal populations was conducted in replicated forest (uncut), clearcut, and clearcut-burned sites from 1988 to 1992 in west-central British Columbia, Canada. Mean species richness was significantly higher on clearcut sites than on forest or clearcut-burned sites. Species diversity was similar over all sites. Although species composition was altered by clearcutting, abundance of all species except southern red-backed voles was the same or higher than that in uncut forest. Prescribed burning of clearcuts may not be necessary to mimic natural disturbance regimes. Clearcutting of northern spruce-fir forest may provide diverse habitats for small mammals through different stages of succession (along with old growth forest) much as wildfires formerly did.)

Ter-Mikaelian, M.T., (R.G. Wagner), F.W. Bell and (C. Shropshire). 1999.

Comparison of photosynthetically active radiation and cover estimation for measuring the effects of interspecific competition on jack pine seedlings.

Can. J. For. Res. 29: 883-889.

(Using an additive-density study with 10 woody and herbaceous plant species of the boreal forest, we

compared equations predicting the biomass growth of jack pine seedlings using measurements of photosynthetically active radiation (PAR) transmission and visual estimates of vegetation cover. Nonlinear regression equations accounted for between 77 and 83% of the variation in annual biomass increment of jack pine when all competing species were combined. Our objective was to determine whether measuring PAR provided any advantage over cover estimation for predicting the effects of interspecific competition. We found no difference in the predictive ability of visual cover estimates and either a single PAR measurement at the point of maximum canopy development or repeated PAR measurements throughout the growing season. Results were consistent among experimental plots that contained a variety of competing plant species with different growth forms. Although the precision of plant cover estimates in vegetation sampling has been a concern for some time, high variation in PAR measurements can be created by sensor location sensitivity, narrow sampling windows, and the need for sensor calibration.)

(Wagner, R.G.), G.H. Mohammed and T.I. Noland. 1999.

Critical period of interspecific competition for northern conifers associated with herbaceous vegetation.

Can. J. For. Res. 29: 890-897. (Using critical-period analysis, we examined the temporal effects of interspecific competition from herbaceous vegetation on seedlings of jack pine, red pine, eastern white pine, and black spruce during the first 5 years after planting. Gains in stem volume index associated with increasing duration of vegetation control (expressed by weed-free curves) differed among species. In contrast, declines in stem volume index with increasing duration of competition after planting (expressed by weed-infested curves) were equal among species. Critical periods for stem volume index were shorter for shade-intolerant jack and red pine (1 and 2 years after planting) than for more shade-tolerant white pine and black spruce (1 to 3 years for spruce and 1 to 4 years for white pine). Intolerant species had greater absolute stem volume growth, but smaller relative declines from continuous association with herbaceous vegetation (85, 81, 78, and 67% for white pine, black spruce, red pine, and jack pine, respectively.) Herbaceous vegetation did not affect survival and had a variable influence on height growth of all species.)

(Wagner, R.G.) and M.T. Ter-Mikaelian. 1999.

Comparison of biomass component equations for four species of northern coniferous tree seedlings.

Ann. For. Sci. 56: 193-199.

(We compare equations predicting the biomass components (foliage, branches, stem, roots, total aboveground and total tree) for seedlings of 4 coniferous tree species: jack pine, red pine, eastern white pine, and black spruce grown under controlled experimental conditions for 3 years. Coefficients of determination (R^2) for the component equations exceeded 0.9 for jack and red pine, and ranged from 0.7 to 0.9 for white pine and black spruce. Basal diameter was the most important variable in all equations. Using statistical comparisons of the full model (i.e., separate equations for each species) with 3 alternative reduced models that pooled various combinations of species, we determined that none of the biomass component equations could be combined among species.)

(Wanner, K.W.), (B.C. Kostyk) and (B.V. Helson). 1999.

Recommendations for control of cone and seed insect pests of black spruce, *Picea mariana* (Mill.) B.S.P., with insecticides.

For. Chron. 75(4): 685-691.

(Foliar sprays of dimethoate and permethrin, applied to run-off 1 week prior to female flower bud flush, significantly reduced flower abortion, cone grazing, and shoot grazing caused by spruce budworm, larvae as well as damage by the spruce cone maggot. Treatment with *Bacillus thuringiensis* resulted in moderate protection from grazing damage to female flowers and cones as compared to treatment with dimethoate and permethrin. Systemic applications of acephate also reduced

damage by spruce budworm larvae and the spruce cone maggot: fall and spring applications were equal in efficacy, and the label rate provided similar protection to the half-label dose.)

Zakrzewski, W.T. 1999.
A mathematically tractable stem profile model for jack pine in Ontario.
N.J. Appl. For. 16(3): 138-143.
(A new model was derived to describe the inside bark cross-sectional area of tree stems. The inputs required are outside bark tree diameter at breast height and total tree height. Knowledge of a species-specific bark thickness at 1.3 m expressed in terms of input variables is also needed. Defining the model involves estimating 2 regression coefficients using either nonlinear or linear regression. The model is analytically solvable for a stem height location at any given inside bark diameter, so that stem sections can be defined by the required inside bark diameter limits. The new model can be calibrated using either section diameter or section volume data. The formula was calibrated for jack pine in Ontario. Wider applicability of the model is supported by results obtained for sugar maple in Ontario and Scots pine in Finland. Comparing volume estimates from the new model with those generated by Honer's formula confirms the advantages of the new model.)

(Zarco-Tejada, P.J.), (J.R. Miller), G.H. Mohammed, T.L. Noland and P.H. Sampson. 1999.
Canopy optical indices from infinite reflectance and canopy reflectance models for forest condition monitoring: Application to hyperspectral CASI data.
In Proc IEEE 1999 Intern. Geoscience and Remote Sensing Symp. (IGARSS'99). Hamburg, Germany, 28 June - 2 July, 1999. 4 p. (This paper reports on progress made to link physiologically based indicators to optical indices from hyperspectral remote sensing. This study was carried out on 12 sugar maple sites in the Algoma Region, Ontario, where field measurements and hyperspectral CASI imagery were collected in 1997 and 1998. Individual tree samples were collected at each site for biochemical analysis of leaf chlorophyll, chlorophyll fluorescence, and carotenoid concentrations, as well as leaf reflectance and transmittance. Physiological indices and derivative analysis indices extracted from leaf spectral reflectance have been tested at canopy level using CASI data of 72 channels and 2-m spatial resolution at 3 simulation scales which progressively more closely represent the observed above-canopy reflectance spectra from the sites: single leaf reflectance data, infinite reflectance calculated from optically thick leaf simulation formulae, and canopy reflectance models using nominal site canopy architecture data. This study shows that selected algorithms connecting leaf reflectance and transmittance data to corresponding bioindicators at the leaf level can be expressed at canopy level through canopy models yielding predictions of bioindicators in airborne imaging spectrometer with coefficients of determination as high as 0.91.)

Publications 2000

(Apps, M.J.), (J.S. Bhatti), (D.H. Halliwell), (H. Jiang) and C.H. Peng. 2000.
Simulated carbon dynamics in the boreal forest of central Canada under uniform and random disturbance regimes.
Ch. 7 *in* Global Climate Change and Cold Region Ecosystems. R. Lal, J.M. Kimble and B.A. Stewart, eds. CRC Press LLC, 243 p.
(This chapter discusses 2 simulation models, previously calibrated and tested for Saskatchewan forests, that are being used to examine the relationships between biomass C, litterfall C, and soil C pools under uniform and random disturbance regimes. CENTURY 4.0, a point model, is used to estimate changes in forest C pools for 2 sites near Prince Albert at the southern border of central Canada's boreal forest. The Carbon Budget Model of the Canadian Forest Sector (CBM-CFS2) is similarly used to examine forest C dynamics at the scale of the entire boreal forest of Saskatchewan. Comparisons of these models with each other and

with observed data are used to validate the soil module of CBM-CFS2.)

Baldwin, D.J.B., (J.R. Desloges) and (L.E. Band). 2000.
Physical geography of Ontario.
Ch. 2 *in* Ecology of a Managed Terrestrial Landscape: Patterns and Processes of Forest Landscapes in Ontario. A.H. Perera, D.L. Euler and I.D. Thompson, eds. UBC Press, 336 p.
(This chapter describes the spatial distribution of the abiotic factors, including bedrock, surficial geology, climate, soils, and hydrology, that influence and interact with the biotic systems and affect landscape-level forest management in Ontario.)

Bell, F.W. 2000.
White birch regeneration.
Pp. 7-8 *in* Proc. Ecology and Management of White Birch Workshop. Wawa, ON, 21-22 Sept. 1999. Ont. Min. Nat. Resour., Bor. Sci., South Porcupine, ON.
(This summary describes the autecology of selected competitive plant species in northern Ontario. Topics covered include natural reproduction, seed viability and germination, vegetative reproduction, propagation, seeding, vegetative propagation, micropropagation, and transplanting.)

Bell F.W., (D.G. Pitt), (A.U Mallik) and (C. Hollstedt). 2000.
Seasonal susceptibility of boreal plants to glyphosate. I. Blue-joint grass and black spruce.
N. J. Appl. For. 17(4): 141-148.
(Seasonal susceptibility and post-treatment recovery of blue-joint grass to glyphosate (N-[phosphonomethyl] glycine) were examined in a young black spruce plantation. In 1990, 2 rates of the herbicide (1.1 and 1.7 kg ae/ha) were applied on July 19, August 1, 15, and 29, and September 10 and 29 using a backpack sprayer. Although differences between rates were marginal, time of application strongly influenced post-treatment cover of blue-joint grass. Compared to the untreated control, glyphosate applied between August 1 and September 10 significantly reduced cover of blue-joint grass for 3 years after treatment and increased growth of black spruce for at least 5 years. The optimum period of glyphosate efficacy corresponded to the end of blue-joint grass's full flowering and beginning of aboveground senescence.)

Bell, F.W., (D.G. Pitt), (M. Irvine), W.C. Parker, L.J. Buse, (N. Stocker), (W.D. Towill), (H. Chen), (F. Pinto), (K. Brown), D. DeYoe, (T. McDonough), (G. Smith) and (M. Weber). 2000.
Intensive forest management in Ontario: Summary of a 1999 science workshop.
Ont. Min. Nat. Resour., Sault Ste. Marie, ON. Sci. Devel. Transf. Ser. No. 003. 86 p.
(This summary of a 1999 intensive forest management (IFM) science workshop presents the combined thought and opinions of 24 speakers and close to 180 participants, representing provincial and federal government management, science, and operations staff; forest industry; and interest groups from across the province, about the elements of the Ontario Forest Accord that relate to intensive forest management. Summaries of speaker presentations and results of facilitated sessions were used to develop recommendations about what is needed to begin implementing IFM in Ontario.)

Bell, F.W., M.T. Ter-Mikaelian and (R.G. Wagner). 2000.
Relative competitiveness of nine early successional boreal forest species associated with planted jack pine and black spruce seedlings.
Can. J. For. Res. 30: 790-800.
(Differences in yield-density models derived from an additive experimental design were used to compare the relative competitiveness of 9 early successional boreal forest plants (aster, grass, fireweed, fern, raspberry, willow, alder, birch, and aspen) on jack pine and black spruce. A randomized complete block split-split-plot design with 3 replications blocked on soil type was used. Initial density gradients were 0–4 plants/m^2 for herbaceous species. Increasing cover and (or) height of all

competitors (except fern) significantly decreased conifer stem diameter. During the years studied, both conifers responded similarly to competition, and herbaceous species were on average 28.9% more competitive than woody species.)

Brodzik, Z. and A.H. Perera. 2000.

Spatially explicit derivation of regional scale wildlife habitat in boreal Ontario.

In GIS 2000. Toronto, ON, 13-16 March 2000. Geo Tech Media, CD-ROM, 11 p.

(This paper describes a spatially explicit method of mapping wildlife habitat in Ontario's northern forest landscape. We selected wildlife species that operate at 2 scales: landscape and forest. We used Landsat TM data to represent vegetation, forest fires, and clearcuts. The wildlife habitat matrices were developed based on an expert systems approach. Landscape indices were used to quantitatively describe spatial habitat patterns.)

Buse, L.J. 2000.

How does science support resource management policy?

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. Insights 4(2): 2-3.

(One of MNR's mandates is to set resource management policy for the province of Ontario. Policy instruments in Ontario take many forms (strategic directions to technical standards and guidelines). So how do scientific principles get incorporated into these documents? The most common ways are: science creates new knowledge to support the development or revision of policy; the scientific method is used to test and refine existing policies; and science develops tools to help resource managers implement policy in their day-to-day operations.)

Buse, L.J. 2000.

Intensive forest management seen as key to increasing wood supply.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. Insights 4(2): 5.

(Intensive forest management (IFM) combines basic forest management with practices aimed primarily at increasing the value and/or volume of desired forest components. In early December 1999, participants from across Ontario attended an Intensive Forest Management (IFM) workshop. The workshop was held to determine how IFM science should be implemented in Ontario. This article describes what's being done with the information collected at the workshop, and where we go from here. (See Bell et al. 2000, Sci. Devel. Transf. Ser. No. 003.))

Cherry, M. and P. Lu. 2000.

Analysis of Copperfield and McEwing tests for the 2nd generation jack pine pilot breeding program.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. Int. Rep. 13 p. + append.

(Data from the jack pine Copperfield and McEwing test were analyzed using Best Linear Unbiased Prediction to determine individual breeding values and genetic gains on the selections for a second generation program. Actual gains could not be estimated, as information about individual tree identities of those selected was not provided. Optimal selections from sets A, B, and C gave a maximum best-case scenario potential genetic gain estimate for height age 9 of 1.61% for the combined elite + infusion populations, assuming no pollen contamination occurred among cones collected for the program. Recommendations for future programs are provided. *(Report not for general distribution.)*)

Colombo, S. and F.W. Bell. 2000.

Indicators of glyphosate resistance in spruce seedlings.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON., Unpubl. Rep. 21 p.

(This report describes the development of indicators of herbicide resistance in spruce seedlings. Herbicide application must be delayed until crop trees are sufficiently hardy to resist damage but when target competing species are still susceptible. Reliable methods are needed to determine the earliest possible dates for herbicide application. Herbicide resistance is closely related to the phenology of crop

trees: elongating shoots bear needles with thin outer layers that allow herbicide to readily enter the tissues. Five phenological indicators were examined: bud development, stem lignification, stem colour, needle cuticular transpiration, and needle wax concentration. Studies used black spruce or white spruce seedlings in their second shoot growth cycle. Herbicide resistance increased as bud development progressed and trees were highly resistant to herbicide 4 weeks after buds were first initiated. While xylem staining was correlated with herbicide resistance in 1 of the studies conducted, variable results in a field trial raises questions about the reliability of this indicator. Another measure of stem maturation, stem colour, gave a more reliable indication of herbicide resistance. Cuticular transpiration and needle wax were correlated with herbicide resistance in some but not all trials. All of the phenological indicators examined provided promising results. However, additional information, especially for older trees in field conditions, is required to develop benchmark values and an understanding of natural variability in the indicators in spruce plantations. (Report for forest industry — *Not for distribution*.))

(Csillag, F.), A. Perera and (H. Wilson). 2000.
Landcover analysis of the Moose River Basin.
Final Rep. to For. Ecosyst. Sci. Coop., Thunder Bay, ON, Unpubl. Rep. and CD-ROM
(This report summarizes an approach used to assess the spatial-temporal characteristics of landcover in the Moose River Basin. Emphasis was on using remotely sensed data to create historical landcover maps, geographical information systems to register images to existing digital data sets and ground surveys, where available, and then to analyze these data by spatial indices that can be interpreted within a landscape ecological framework. An accompanying CD-ROM provides the maps and digital data. (*Not distributed by OFRI. For information, contact the Forest Ecosystem Science Coop in Thunder Bay.*))

(Euler, D.L.), (I.D. Thompson) and A.H. Perera. 2000.
Reflections on the managed forest landscape.
Ch. 16 *in* Ecology of a Managed Terrestrial Landscape: Patterns and Processes of Forest Landscapes in Ontario. A.H. Perera, D.L. Euler and I.D. Thompson, eds. UBC Press, 336 p.
(Ontario forest managers must address 2 central issues; the first is the real goal of forest sustainability and the second is whether forest changes caused by human activity lie within the range of variation that might be expected from natural ecological forces. This chapter highlights major changes underway in Ontario forest management, future influences on Ontario's forest landscapes, research requirements for the future, and fundamental landscape ecology issues underlying forest management.)

(Fleming, R.A.), (A.A. Hopkin) and J.N. Candau. 2000.
Insect and disease disturbance regimes in Ontario's forests.
Ch. 8 *in* Ecology of a Managed Terrestrial Landscape: Patterns and Processes of Forest Landscapes in Ontario. A.H. Perera, D.L. Euler and I.D. Thompson, eds. UBC Press, 336 p.
(Issues discussed in this chapter include Ontario's major insect and disease disturbances (softwood and hardwood defoliators), Ontario's major forest diseases, abiotic disturbances, large-scale dynamics of insect and disease disturbances (spruce budworm disturbances, insect interactions with fire), and the population biology of the spruce budworm outbreak cycle (processes behind the cycle as they link to landscape-level dynamics in Ontario's forest).)

Greifenhagen, S. and (A.A. Hopkin). 2000.
After the ice storm: Decay, stain, and wood-boring beetles.
Ont. Min. Nat. Resour., Sault Ste. Marie, ON., Ice Storm For. Res. Tech. Transf. (Tumble). 4 p.
(This booklet summarizes the types of decay, stain, and beetles that can affect ice damaged trees in southern Ontario, identifies which trees are most susceptible, and gives landowners a sense of when they need to be concerned about potential damage.)

Greifenhagen, S and G. Halicki-Hayden. 2000.
Imidacloprid reduces *Lygus lineolaris* damage to white pine seedlings.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. For. Res. Note No. 59. 8 p.
(Lygus bugs are serious pests of numerous plant

species worldwide, including alfalfa, beans, stawberries, peaches, and tomatoes. In Ontario, lygus bug damage occurs mainly in jack pine and white pine container and bareroot crops, although black spruce and white spruce seedlings are also affected. Typical symptoms include the development of weak multiple leaders, terminal shoot distortion, and thick, short, twisted needles. Three nylon mesh insect inclusion cages per treatment were placed in the greenhouse in a randomized block design. Multipot trays remained in the cage for 2-week intervals. One tray remained in each cage for the entire 8-week period. The levels of lygus bug exposure in the experiment caused significant damage to white pine seedlings. Insecticide rate, exposure date, and their interaction were both significant. Imidacloprid (systemic insecticide readily absorbed by plant root systems) reduced seedling damage caused by lygus bug feeding. Recommendations are given to increase the effectiveness of the treatment.)

(Haddow, K.A.), (D.J. King), (D.A. Pouliot), (D.G. Pitt) and F.W. Bell. 2000.

Early regeneration conifer identification and competition cover assessment using airborne digital camera imagery.

For. Chron. 76(6): 915-928.

(The potential of low cost, high-resolution airborne digital camera imagery for use in early stage forest regeneration assessment was investigated. Airborne imagery with a 2.5-cm pixel size was acquired near Sault Ste. Marie, Ontario, over a forest vegetation management research site to (1) evaluate capabilities for identification and stem counting of 2-year-old conifer crop species under leaf-off and leaf-on conditions using classification of spectral and textural image information, and (2) develop models relating vegetation cover parameters to image spectral and texture information. Results indicate strong potential for identification and counting of conifer trees when competing vegetation cover is low or in leaf-off condition. However, systematic decreases in class separability and conifer count accuracy were observed with increasing competition. In image modelling of competition leaf area index and cover, statistically significant relations were found using primarily spectral measures. Stratifying by competition species improved model fits and included texture measures in some models.)

(Kuessner, R.), (P.E. Reynolds) and F.W. Bell. 2000.

Growth response of *Picea mariana* seedlings to competition for radiation.

Scand. J. For. Res. 15(3): 334-342.

(The growth response of 4-year-old black spruce seedlings to reduced radiation availability caused by herbaceous and woody competitors was investigated on a clay and a loam site on a research plot in Ontario, Canada. Variability in black spruce growth was less correlated to reduced radiation availability caused by woody competitors than resource competition from herbaceous plants. On the clay site, competition from fireweed, Canada blue-joint grass and red raspberry decreased black spruce diameter by more than 40% compared to seedlings without competition. Canada blue-joint grass and fireweed also distinctly reduced black spruce diameter performance on loam (>30%). These results are discussed in relation to the need for vegetation control.)

Lautenschlager, R.A. 2000.

Can intensive silviculture contribute to sustainable forest management in northern ecosystems?

For. Chron. 76(2): 283-296.

(In the midst of changing social, ecological, and technical realities, interest in intensive silviculture has resurfaced. Although integrated landscape management is increasingly becoming the foundation for forest management, silvicultural direction remains unclear. Silviculturalists and managers will reap rewards by increasing silvicultural intensity only if their plans are scientifically based and socially acceptable. Before reasonable silvicultural directions can be developed, responsible parties need to frame and agree on the most realistic approaches that address both social and ecological concerns. Calls for increased silvicultural intensity are based on the recognition that status quo management could result

in increasing fibre imports to satisfy local producer and consumer needs. Still, much of our naturally less productive northern forested landbase seems far from ripe for increasing silvicultural intensity dramatically. Even so, those who continue status quo forest management solely may become increasingly less competitive. In an increasingly interdependent, world market-based economy, it is unclear whether intensive silviculture in northern ecosystems can be competitive with production in other parts of the world.)

Lautenschlager, R.A. 2000.

Identifying specific indicators of sustainable forest management.

Pp. 7-9 *in* Proceedings, From Science to Management and Back: A Science Forum for Southern Interior Ecosystems of British Columbia. C. Hollstedt, K. Sutherland and T. Innes, eds. Kamloops, B.C., Dec. 1999. Southern Interior For. Ext. Res. Partnership, 150 p.

(An introduction to the *Identify the Specifics* approach, which seeks to integrate local knowledge through broad-scale social or ecological experts and results in the development of concern matrices that identify and prioritize concerns about management practices at local and increasingly broader scales.)

Lautenschlager, R.A. 2000.

Wildlife uses of white birch.

Pp. 15-17 *in* Proc. Ecology and Management of White Birch Workshop. Wawa, ON, 21-22 Sept. 1999. Ont. Min. Nat. Resour., Bor. Sci., South Porcupine, ON. (This summary focusses on wildlife use of white birch for both food and cover. White birch is but one of a mix of angiosperm species, often used in proportion to their abundance, found in northern ecosystems. The primary connection between wildlife and white birch use has been observations of feeding on aboveground parts, with an indication that excessive and/or repeated feeding on aboveground parts results in dramatically lower forage quality in the regrowth. Animals that feed on white birch are listed and the specific parts consumed are summarized. A number of northern wildlife species make considerable use of white birch throughout the year.)

Lautenschlager, R.A., (H. McLeod), (C. Hollstedt) and (D. Balsillie). 2000.

Examining the *Specifics* approach to identifying indicators of sustainable natural resource management in Ontario, Saskatchewan, and British Columbia.

For. Chron. 76(5): 725-738.

(Natural resource managers, environmental interest groups, and public agencies need identifiable, measurable indicators of sustainability based on meaningful fine-scale specifics that are appropriate for both fine and increasingly broader social/ ecological scales. The identify the specifics framework, field tested in Ontario, Saskatchewan, and British Columbia, uses collective local expert knowledge to integrate and prioritize social/ ecological concerns that become the foundation for both local and increasingly broader-scale indicators of sustainable management. Results to date suggest that local experts have valuable knowledge to contribute; identified local indicators can contribute to both local and broader-scale indicators; fewer than 10 indicators may provide an adequate foundation for assessing the sustainability of local range and forest management practices; and local and broader-scale experts commonly identify different indicators because they have different knowledge bases, priorities, and responsibilities. Differences may be minimized if indicators at broader scales are developed with knowledge of specifics from finer scales. The specifics approach is presently being used across British Columbia to help identify knowledge gaps and related research and extension priorities.)

Lu, P. and M. Cherry. 2000.

Analysis of Denton and Egan family tests for second generation black spruce breeding in seed zone 24.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Int. Rep. 63 p. + append.

(Progeny test data from Denton and Egan family tests in seed zone 24 in northern Ontario were reanalyzed to check the estimates of genetic

parameters and predicted gains. Parental- and individual-tree breeding values were predicted using the method of best linear unbiased prediction with combined data from both tests. Predicted genetic gain in 9-year height from family roguing in a seedling seed orchard varied from 2 to 4% when 50 to 80% of the families were culled. Genetic gains in the second generation breeding population were predicted to be 7.5, 6.4, and 6.6% for the elite, infusion, and entire breeding populations, respectively, based on predicted breeding values. Genetic gains from the various selection methods are compared and recommendations provided. (*Report not for general distribution.*))

MacDonald, G.B. 2000.

Harvesting boreal mixedwood stands to favour conifer regeneration: Project establisment and early results.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 157. 20 p.

(Silvicultural trials were established near Chapleau and Cochrane in northern Ontario to investigate techniques for enhancing the conifer component in boreal mixedwood stands. The Chapleau trial produced similar harvesting and skidding productivity for clearcutting and partial cutting. Windthrow losses were high for residual trees greater than 10 cm in diameter. Third-year survival of planted white spruce and jack pine was affected by harvesting level but not by weeding frequency. There was a strong interaction between harvesting and weeding for most response variables. Partial cutting improved species richness, while weeding reduced it. Harvesting productivity in the Cochrane trial was higher for clearcutting than partial cutting, but skidding productivity was similar for both treatments. Logging damage was higher for clearcutting than partial cutting, but there was no difference in damage from natural causes between the harvesting levels. Clearcutting produced 44,000 hardwood stems per ha the first year after cutting, which was more than double the densities after partial cutting. Partial cutting is recommended for producing a boreal mixedwood stand with a viable conifer component in the subsequent rotation. Partial cutting and careful logging in mixedwood stands are economically feasible, but require multi-rotation planning and adequately trained operators.)

(Mäkelä, A.), (J. Landsberg), (A.R. Ek), (T.E. Burk), M. Ter-Mikaelian, (G.I. Ågren), (C.D. Oliver) and (P. Puttonen). 2000.

Process-based models for forest ecosystem management: Current state of the art and challenges for practical implementation.

Tree Physiol. 20: 289-298.

(Current state-of-the-art in process modelling is discussed in the context of forest ecosystem management. We argue that the carbon balance approach is readily applicable for projecting forest yield and productivity, and review several carbon balance models for estimating stand productivity and individual tree growth and competition. To develop operational models, it is necessary to accept that all models may have both empirical and causal components at the system level. We present examples of hybrid carbon balance models and consider issues that currently require incorporation of empirical information. We also review model calibration and validation methods that account for the hybrid character of models. Operational implementation of process-based models to practical forest management is discussed.)

Mallory, E.C., (M.S. Ridgway), (A.M. Gordon) and (N.K. Kaushik). 2000.

Distribution of woody debris in a small headwater lake, central Ontario, Canada.

Arch. Hydrobiol. 148(4): 587-606.

(The distribution of woody debris in the littoral zone of a small, oligotrophic headwater lake in south central Ontario, Canada was studied. Coarse woody debris (CWD) was defined as pieces of wood with a large end diameter and medium woody debris (MWD) as pieces of wood with a small end diameter. The mean length, diameter, and volume of CWD were 530.4 cm, 17.3 cm and 181.9 dm^3, respectively. For MWD, these parameters were 52.2 cm, 5.0 cm and 1.43 dm^3, respectively. CWD was

present at 1.18 pieces/m shore line occupying a volume of 0.212 m^3/m, while MWD was present at 24 pieces/m shore line occupying a volume of 0.034 m^3/m. There were significant correlations between the slope of the ecotonal lake bottom and number of CWD pieces found at each site and between water depth and volume of MWD, which suggests a trend for greater accumulation in steeper, deeper areas as opposed to shallower bays.)

McLaughlin, J. 2000.
DOT: A solution for Annosus root rot.
Ont. For. Prod. Market. Bull., Ont. For. Assoc. Sept/Oct: 1-2.
(After the withdrawal of the registration of borax (sodium tetraborate decahydrate) to control the spread of annosus root rot in red pine plantations in Ontario and alternatives were sought. One potential alternative is DOT (disodium octaborate tetrahydrate, sold as Tim-bor), a borate formulation that is registered as a protector of wood against decay fungi. This article provides guidelines for and costs of using DOT for root rot control.)

McLaughlin, J. 2000.
Pathological effects and management implications.
Pp. 19-20 *in* Proc. Ecology and Management of White Birch Workshop. Wawa, ON, 21-22 Sept. 1999. Ont. Min. Nat. Resour., Bor. Sci., South Porcupine, ON.
(This summary covers the pathology of white birch in natural established stands including decay, cankers, stain, and dieback/decline; the post-logging pathology of white birch or *post-logging decadence* including symptoms and causes; as well as strategies to reduce post-logging decadence for residual white birch trees.)

McLaughlin, J.W., (M.R. Gale), (M.F. Jurgensen) and (C.C. Trettin). 2000.
Soil organic matter and nitrogen cycling in response to harvesting, mechanical site preparation, and fertilization in a wetland with a mineral substrate.
For. Ecol. Manage. 127(1): 7-23.
(Forested wetlands are becoming an important timber resource in the Upper Great Lakes Region of the US. However, there is limited information on soil nutrient cycling responses to harvesting and post-harvest manipulations such as site preparation and fertilization. The objective of this study was to examine cellulose decomposition, nitrogen mineralization, and soil solution chemistry 4 years after a forested, mineral soil wetland in northern Michigan was whole-tree harvested, site prepared, and fertilized (N, P, N + P). Organic matter decomposition was greatest in the site preparation bedding treatment and lowest in the whole-tree harvested, not site prepared area. Both N and P additions, alone and in combination, increased cellulose decomposition regardless of site preparation treatment (15-38% for the harvest-only treatment, 20-40% for the bedded treatment, and 15-44% for the trenched treatment). However, based on dissolved organic carbon concentrations in the soil solution, organic matter decomposition was inhibited outside the area of cellulose strip placement. The site preparation bedding treatment resulted in a net mineralization of N over a 10-week incubation period, whereas the disc trench and harvest-only treatments resulted in a net immobilization of N. Nitrogen, P, and N + P inhibited N mineralization in the bedded treatment by 10-25% over the control. There was a fertilizer-induced increase in N immobilization of 50-60% and 25-50%, in the harvest-only and trenched treatments, respectively. It appears that soil microorganisms at this site are limited by soluble C more than N or P. By adding cellulose strips to the soil, the soluble C limitation was, in part, overcome and the soil microorganisms could respond positively to N and P additions.)

Mohammed, G.H., T.L. Noland, D. Irving, P.H. Sampson, (P.J. Zarco-Tejada) and (J.R. Miller). 2000.
Natural and stress-induced effects on leaf spectral reflectance in Ontario species.
Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 156. 34 p.
(This study explores some of the biological factors influencing leaf-based spectral reflectance. Forty-four species were examined for species effects.

Some general patterns were revealed, including: low reflectance in the near infrared region for conifers compared to broadleaved species; higher reflectance in the blue wavebands for species with blue hues in their foliage; and more rapid decay of the green spectral peak in deciduous tree and shrub species. However, the influence of species was easily superceded by other factors, such as leaf age, leaf side, and stress status. The effects of stresses such as senescence and herbicide on leaf reflectance were evident prior to the appearance of visual symptoms. The application of spectral indices was a useful means to quantify previsual changes in spectral reflectance. The red edge inflection point was well correlated with chlorophyll content. Pooling a range of coniferous species and stock types, the Photochemical Reflectance Index (PRI) was a promising early indicator of strain. Normalized difference vegetation indices (NDVI) had limited correlation to pigments and other physiological indicators of stress status. Altogether, 11 indices reported in the literature were tested. These findings suggest that leaf reflectance may be an effective early indicator of physiological strain.)

Obenchain, A.M. 2000.

Ice damage research update: What tree roots can tell us about maple syrup production.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. Insights 4(2): 4.

(Can looking at maple roots in the fall reveal whether the next spring's syrup season will be a sweet success? OFRI scientists report yes. Tom Noland and his assistants used an increment borer to collect 450 samples of maple roots across the 1998 ice damage area. Research confirms that more crown damage means less root starch in the fall and less sap in the spring. Researchers are also investigating the link between the level of damage and the tree's ability to heal wounds. In the long term, this work could lead to practical tests for using root starch samples to predict future syrup production and tree survival after damage.)

Obenchain, A.M. (ed.). 2000.

Insights.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. 4(2): 8 p.

(This issue of OFRI's newsletter highlights non-timber forest products, linking science and policy, predicting sap production after ice damage, intensive forest management workshop, PC version of LEAP II, and a new method for developing a provincial ecological hierarchy.)

Obenchain, A.M. 2000.

LEAP II is ready to leap to a PC near you.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. Insights 4(2): 6.

(OFRI has released a Windows NT version of the Landscape Ecological Analysis Package 2.0 or LEAP II, developed by a team of OFRI researchers. This software is a generic tool that allows the user to define analysis objectives. It analyzes landscape patterns and summarizes the information into indices that quantify the ecological status of a given landscape. (See also Perera et al. 1997, Forest Research Report No. 146.))

Obenchain, A.M. 2000.

New ecologically based landscape classification method shows promise for Ontario.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. Insights 4(2): 7.

(See Band et al. 1999, Forest Research Report No. 149.)

Obenchain, A.M. 2000.

Non-timber forest products provide opportunities, challenges for forest management.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. Insights 4(2): 1-2.

(Interest in non-timber forest products (NTFPs) is growing rapidly. Gina Mohammed, author of *Non-Timber Forest Products in Ontario: An Overview* (Forest Research Information Paper No. 145), believes that developing the NTFP industry will benefit a broad range of stakeholders. Some examples include: smaller communities, especially in the north and on

First Nations reserves; forest industry; and the public. Challenges include lack of scientific knowledge, potential overexploitation, conflicts among users, and lack of knowledge about economic development. Meetings were held recently in Ontario to help address these issues.)

OMNR. 2000.

Ontario Climate Model: Version 2.0.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON, CD-ROM.

(This CD-ROM contains the June 2000 release of Ontario's 1961-1990 average climate grids. Instructions for importing the data into ArcView and ArcInfo software are provided.) (*Limited copies available for internal distribution only.*)

Papadopol, C.S. 2000.

Impacts of climate warming on forests in Ontario: Options for adaptation and mitigation.

For. Chron. 76(1): 139-149.

(This paper summarizes current knowledge about the optical properties of greenhouse gases and general climate-warming influences. It analyzes the warming trends in Ontario based on data from 2 weather stations with continuous records of more than 120 years, to determine the rate of warming in the Great Lakes-St. Lawrence Region. The results indicate a temperature increase of about 0.76°C per century and an 8% increase in annual total precipitation. The consequences of climate warming on (a) northward shifts of ecological conditions, (b) forest productivity, and (c) forest physiology and health, are examined. In the context of global warming, the paper recommends practical management measures necessary to ensure adaptation of existing forest ecosystems to the warming that is occurring.)

Parker, W.C. and G.H. Mohammed. 2000.

Photosynthetic acclimation of shade-grown red pine (*Pinus resinosa* Ait.) seedlings to a high light environment.

New For. 19:1-11.

(Photosynthetic light acclimation in red pine seedlings was examined in a greenhouse study to better understand the physiological response of this species to increased light intensity following release from competition. Seedlings grown in high (HL), medium (ML), or low (LL) light environment for 12 weeks were transferred to high light. Gas exchange and chlorophyll fluorescence of ML and LL seedlings were measured prior to and following transfer and compared with the HL control treatment. Photosynthetic characteristics were related to initial light treatment and time after transfer. Acclimation of gas exchange features to high light in shade-formed ML and LL foliage was relatively rapid, with similar values among light treatments within 57 days of transfer. Acclimation of net photosynthetic rate was similar in ML and LL seedlings and was associated primarily with increased mesophyll conductance to CO_2. The ratio of variable to maximal chlorophyll fluorescence decreased initially after the transfer, especially in LL seedlings, but recovered to normal values after 57 days. Red pine seedlings appear to be well adapted for photosynthetic acclimation to high light intensity, consistent with that reported for other early successional tree species.)

Parker, W.C., S.J. Colombo, M.L. Cherry, (M.D. Flannigan), S. Greifenhagen, (R.S. McAlpine), C. Papadopol and (T. Scarr). 2000.

Third millennium forestry: What climate change might mean to forests and forest management in Ontario.

For. Chron. 76(3): 445-463.

(Climate change may profoundly influence Ontario's forest ecosystems and their management. Elevated atmospheric CO_2 concentrations, increased temperature, and altered precipitation regimes will affect forest vegetation through their influence on physiological and ecological processes, and may result in dramatic northward shifts in the natural range of forest types and species. More importantly, climate change is expected to increase the frequency of natural disturbances. Silvicultural intervention will increasingly be relied on to maintain forest health, manage declining stands, regenerate disturbed areas and cutovers with desired species level approaches an

and genotypes, maintain genetic diversity, and assist in species migration. Given the increasingly important role of Ontario's forests in national and provincial efforts to meet greenhouse gas emission reduction targets of the Kyoto Protocol, afforestation, conservation of existing forests, and increased forest management activities to accelerate the shortage of carbon in Ontario's forests will be the key aspects of forestry at the start of the third millennium.)

Peng, C.H. 2000.

From static biogeographical model to dynamic global vegetation model: A global perspective on modelling vegetation dynamics.

Ecol. Model. 135: 33-54. (Predicting the effects of future climatic change and human disturbances on natural vegetation distribution requires large-scale biogeographical models. This paper reviews and compares 2 major types of static biogeographical models, climate-vegetation classification and plant function type models, and the first generation of Dynamic Global Vegetation Models (DGVMs). The advantages and disadvantages of each type of model are discussed. Some DGVMs are able to capture the responses of potential natural vegetation to climate change with a strong orientation towards population processes. Nevertheless, the uncertainty around the quantitative simulated results indicates that DGVMs are still in the early stages of development. Validating and capturing disturbance-related effects are major challenges facing the developers of the next generation of these models. DGVMs will become an important tool for assessing the effects of climate change on potential vegetation dynamics and terrestrial carbon storage and for managing terrestrial ecosystem sustainability.)

Peng, C.H. 2000.

Growth and yield models for uneven-aged stands: Past, present, and future.

For. Ecol. Manage. 132: 259-279.

(Over the years, a variety of models have been developed for predicting the growth and yield of uneven-aged stands using both individual and stand-Modelling methodology not only has moved from an empirical approach to a more ecological process-based mechanistic approach, but also has incorporated a variety of techniques, such as (1) systems of equations, (2) nonlinear stand table projections, (3) Markov chains, (4) matrix models, and (5) artificial neural network models. This paper reviews the current literature on growth and yield models for uneven-aged stands, discusses basic types of models and their merits, and reports recent progress in modelling the growth and dynamics of uneven-aged stands. Furthermore, future trends involving integration of new computer technologies (object-oriented programming and user-friendly interfaces), tree visualization techniques, and the spatially explicit application of Geographical Information Systems (GIS) into uneven-aged modelling strategies are discussed.)

Peng, C.H. 2000.

Understanding the role of forest simulation models in sustainable forest management.

Environ. Impact Assess. Rev. 20: 481-501.

(This paper reviews and compares major types of forest simulation models: (1) growth and yield models (empirical approach); (2) succession models (empirical-mechanistic hybrid approach); and (3) process models (mechanistic approach), and describes 3 case study examples. The advantages and disadvantages of the different modelling approaches are discussed. The case studies deal with predicting future forest stocks under different management options, simulating the potential effects of climate change, and effects of fire disturbance on structure and function of forest ecosystems in Canada. There is still a gap between foresters and ecologists in developing and using forest simulation models. Diversified modelling approaches integrated into a decision-support system, which will become an important tool for evaluating the sustainability of forest ecosystems in a changing environment, are emphasized.)

Peng, C.H., (J. Liu), (M. Apps), (Q. Dang) and (W. Kurz) 2000.

Quantifying Ontario's forest carbon budget. I. Carbon stocks and fluxes of forest ecosystems in 1990.

Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Rep. No. 158. 20 p.

(The Ontario Ministry of Natural Resources (OMNR) has developed a strategic approach to the design and implementation of climate change programs in support of Ontario's commitment to reduce its greenhouse gas emissions by 6% from 1990 levels by 2010. One of the first critical steps is to quantify the 1990 carbon (C) stocks and fluxes on managed forest lands in Ontario. In this study, we adapted the well-established *Carbon Budget Model for the Canadian Forest Sector* (CBM-CFS2), a national-scale model for forest sector C budgets, to estimate the C stocks and fluxes of Ontario's forest ecosystems. We used extensive provincial and national databases, including forest inventory and growth and yield plot data and ecosystem disturbance records. Preliminary results suggest that about 12.65 Pg C was stored in Ontario's forest ecosystems in 1990, which amounts to about 15% of the national forest C budget. Geographically, forest age structure, C stocks, and C density was 179 Mg ha $^{-1}$, including 24 Mg ha $^{-1}$ for biomass and 155 Mg ha $^{-1}$ for litter and soil. About 87.7% of total C is estimated to reside in the boreal region of northern Ontario, while only 12.3% occurs in the temperate region of southcentral Ontario. For all of Ontario's forest ecosystems about 0.27 Pg C was absorbed by forests in 1989-1990. Annual litterfall is estimated at 0.23 Pg C, of which 0.11 Pg is from aboveground and 0.12 Pg is from belowground biomass. Annual C release to the atmosphere from forest litter and soil is estimated at 0.30 Pg C. Although the moderate temperate zone of southern Ontario was estimated to be a small C sink of 0.68 Tg C, the net C balance of Ontario's forest ecosystems was estimated at about -0.03 Pg C for 1990, indicating forests act as a small net CO_2 source and provide positive feedback to global warming. However, this study does not include C taken up and released by forested peatlands or the forest products sector. These are currently being investigated.)

Perera, A.H. and D.J.B. Baldwin. 2000.
Spatial patterns in the managed forest landscape of Ontario.
Ch. 5 *in* Ecology of a Managed Terrestrial Landscape: Patterns and Processes of Forest Landscapes in Ontario. A.H. Perera, D. L. Euler I. D. Thompson, eds. UBC Press, 336 p.
(This chapter provides an overview of the spatial characteristics of Ontario's managed forest landscape and discusses the ecological implications of these characteristics. Other topics include ecoregional patterns in Ontario, land cover patterns at a provincial scale, land cover patterns in the forest management zone (spatial patterns of the forest cover, age classes, forest harvest, and forest fire), and ecological implications and future directions for landscape ecological studies in Ontario.)

Perera, A.H. and (D.L. Euler). 2000.
Landscape ecology in forest management: An introduction.
Ch. 1 *in* Ecology of a Managed Terrestrial Landscape: Patterns and Processes of Forest Landscapes in Ontario. A.H. Perera, D. L. Euler I. D. Thompson, eds. UBC Press, 336 p.
(This chapter provides a brief overview of landscape ecology, from development of the basic concepts to the adaptation of these concepts to the study of forested landscapes, with special reference to forest management.)

Perera, A.H., (D.L. Euler) and (I.D. Thompson). 2000.
Ecology of a Managed Terrestrial Landscape: Patterns and Processes of Forest Landscapes in Ontario.
Ont. Min. Nat. Resour., UBC Press, Vancouver, BC. 330 p.
(This book responds to the increasing need of forest policy developers, planners, and managers for an integrated, comprehensive perspective on ecological landscapes. The book examines the big picture of ecological patterns and processes through a case study of the vast managed forest region in Ontario. The contributors synthesize current landscape ecological knowledge of this area and look at gaps and future research directions from several points of view: spatial patterns, ecological functions and processes, natural disturbances, and ecological responses to disturbance. They also discuss the integration of landscape ecological knowledge into

forest management policies, particularly with respect to Ontario's legislative goals of forest sustainability. This is the first book to describe the landscape ecology of a continuously forested landscape in a comprehensive manner. *(Not available from OFRI — Order from UBC Press.)*)

(Pitt, D.G.), (A.M. Morneault), (P. Bunce) and F.W. Bell. 2000.

Five years of vegetation succession following vegetation management treatments in a jack pine ecosystem.

N. J. Appl. For. 17(3): 100-109.

(Five years of data on vegetation dynamics and succession are provided for 6 operational release treatments applied to 3, 2- to 4-year-old, jack pine plantations in central Ontario. Treatments included 3 years of annual non-crop vegetation removal, conventional aerial spray with glyphosate, ground application of glyphosate with a mist blower, basal bark applications of triclopyr, motor-manual cutting, and no treatment. Conventional aerial spraying and annual removal resulted in the greatest jack pine crop growth, with trees exceeding 90% crown closure, 7 cm in groundline diameter, and 3 m in height after 5 growing seasons. Cover of herbaceous plants was highest in the aerial spray plots during the observation period. Mist-blower and brush saw plots contained mid-size pine with 69% crown closure. In contrast, untreated and basal bark plots contained the smallest pine (31% crown closure), likely caused by heavy competition and herbicide damage, respectively. Successional trends suggest that aerial spray and annual removal treatments will produce pure jack pine stands at maturity; mist blower, basal bark, and brush saw treatments may produce mixedwood stands, and untreated plots will likely be dominated by hardwoods.)

(Pitt, D.G.), (U. Runesson) and F.W. Bell. 2000.

Application of large- and medium-scale aerial photographs to forest vegetation management: A case study.

For. Chron. 76(6): 903-913.

(Five experimental conifer release treatments applied to each of 4, 3- to 7-year-old spruce plantations resulted in a mosaic of woody and herbaceous vegetation complexes after 2 growing seasons. A combination of 1:5,000-scale overview and 1:500-scale sample photographs were evaluated as a means of mapping and quantifying cover in each of 8 vegetation and 2 non-vegetation categories. On 23-cm format, 1:5,000-scale photographs, blocks were stereoscopically stratified into areas of uniform vegetation. A random selection of 80 70-mm format, 1:500 photo samples were then used as training sites to calibrate strata assessment on the 1:5,000 photographs. Verification plots suggested that principle vegetation components such as tall, mid, and low shrub, grass, and herbaceous species were estimated to within 5-10% cover, at least 70% of the time. Errors for lesser components, such as dead shrub, conifer, bare ground, and slash were 2-5% cover. Ferns could not be discerned at the 1:5,000 scale and there was evidence of occasional confusion between herbaceous species and other life forms. Operational applications of the methodology are discussed.)

Remmel, T.K. and A.H. Perera. 2000.

Accuracy of remotely sensed fire mapping assessed with a GIS database.

In GIS 2000. Toronto, ON, 13-16 March 2000. Geo Tech Media, CD-ROM, 11 p.

(Levels of decrease in the Normalized Difference Vegetation Index (NDVI) have been used to identify and map vegetation senescence and forest fire disturbances on satellite imagery. We compared 3 thresholds of NDVI decrease. An existing GIS database of fire patterns was used as ground truth for assessing the accuracy of the threshold mapped fire images. We tested the hypotheses that the 3 threshold methods equally mapped the areas of wildfires. This paper presents the detailed methodology and results of the accuracy comparison.)

(Reynolds, P.E.), F.W. Bell, (J.A. Simpson), R.A. Lautenschlager, (A.M. Gordon), (D.A. Gresch) and (D.A. Buckley). 2000.

Alternative conifer release treatments affect competition levels, available light, net assimilation rates, and growth of white spruce seedlings.

J. Sust. For. 10(3/4): 277-286.

(This study was initiated to measure G_s (stomatal

conductance), E (transpiration), and NA (net assimilation) rates and growth response of released white spruce seedlings and to determine if *in situ* rates of G_s, E, and NA are reasonable predictors of future growth. Because treatment-related PAR, G_s, E, and NA differences appear to be similar to those for growth, this trend suggests that these parameters may provide good indicators of both short- and longer-term treatment-related growth responses. However, these *in situ* differences are not necessarily indicative of physiological adaptation of the seedlings to their new environments. To test whether such adaptation may have occurred, it will be necessary to evaluate gas exchange rates of foliar samples collected from all treatments under a common standardized light environment.)

(Reynolds, P.E.), F.W. Bell, R.A. Lautenschlager, (J.A. Simpson), (A.M. Gordon), (D.A. Gresch), (D.A. Buckley) and J.A. Winters. 2000.
Microclimate changes following alternative conifer release treatments continued through three post-treatment growing seasons.
J. Sust. For. 10(3/4): 267-275.
(This study documents below- and near-ground microclimatic changes associated with several alternative conifer release treatments in the boreal mixedwood forest type. Objectives were to quantify treatment-related microclimatic changes and to determine the duration of the changes. The various microclimatic changes produced microsite conditions favourable for seedling growth, and released seedlings exhibited higher photosynthetic rates and growth than controls.)

(Reynolds, P.E.), (N.V. Thevathasan), (J.A. Simpson), (A.M. Gordon), R.A. Lautenschlager, F.W. Bell, (D.A. Gresch) and (D.A. Buckley). 2000.
Alternative conifer release treatments affect microclimate and soil nitrogen mineralization.
For. Ecol. Manage. 133: 115-125.
(Objectives of this study were (1) to quantify soil nitrification rates for the control, glyphosate, brushsaw, and unharvested forest treatments and (2) to relate these rates to soil temperature and moisture. During the second post-treatment growing season (1995), soil samples were collected at 5-, 15-, and 30-cm depth and incubated in polyethylene bags at the same depth from which they were collected for 30 days prior to exhumation. The above procedure was repeated from June to September. In the third post-treatment growing season (1996), bags were buried at 5 cm only and exhumed 30 days after burial. Higher levels of nitrate were observed for the glyphosate and brushsaw treatments in August 1995 compared with the control and unharvested forest treatments. Rates of ammonium and nitrate production decreased with soil depth and exhibited a distinctive seasonal trend, decreasing as soil temperatures declined. Ammonium production was significantly correlated with soil temperature and moisture, increasing with increasing temperature, and decreasing at higher moisture levels. By the third post-treatment (1996) growing season, no treatment-related differences were observed, and ammonium production was less correlated with soil temperature than during the second post-treatment growing season. These results affirm that application of glyphosate is the best of the options evaluated for effective weed control and optimal nutrient release.)

Sampson, P.H., G.H. Mohammed, (P.J. Zarco-Tejada), (J.R. Miller), T.L. Noland, D. Irving, (P.M. Treitz), S.J. Colombo and (J. Freemantle). 2000.
The Bioindicators of Forest Condition Project: A physiological, remote sensing approach.
For. Chron. 76(6): 941-952.
(The Bioindicators of Forest Condition Project seeks to develop a Forest Condition Rating system using a physiological, remote sensing approach. This project will test whether hyperspectral remote sensing may be used to infer stand-level information about pigment concentration, chlorophyll fluorescence, and other physiological features of condition. The project spans a 4-year period of intensive sampling in tolerant hardwood forests in Ontario using the Compact Airborne Spectrographic Imager. For each airborne campaign, concurrent ground-based sampling for leaf physiological features was performed. Controlled laboratory and greenhouse studies were also conducted to derive relationships between leaf-based spectral measurements and physiology in the presence of

environmental stresses. The project has identified several promising bioindicators of strain that are discernible from hyperspectral images and related to ground-based physiology. The most promising indicator for semi-operational testing is estimation of chlorophyll content, which can be used to classify maple stands on a 5-stage scale of health. The intent of this paper is to update the forestry community on progress, insights gained, and the practical implications of the research.)

Schnekenburger, F., A. Perera and (F. Csillag). 2000.
Using AVHRR/NDVI data to predict forest landscape net primary productivity.
In GIS 2000. Toronto, ON, 13-15 March 2000. Geo Tech Media, CD-ROM, 9 p.
(We implemented a modelling and analytical process to derive monthly provincial-scale surfaces and regional summaries of net primary productivity (NPP) for Ontario, for the years 1992 to 1994. We used remotely sensed data, meteorological data, and a GIS system. Ultimately, NPP surfaces were derived as the product of the light use efficiency (LUE) and absorbed PAR (APAR) surfaces.)

Schroeder, D. and A.H. Perera. 2000.
A method to analyze spatial patterns of post-disturbance revegetation in boreal forests.
In GIS 2000. Toronto, ON, 13-16 March 2000. Geo Tech Media, CD-ROM, 9 p.
(We present a method to compare spatial vegetation patterns resulting from different disturbance types in the boreal forest. A suite of indices measuring landscape heterogeneity was used to describe geometry, composition, and contagion of patches. Vector layers of clearcuts and wildfires from 4 decades, and their multivariate attributes, were used to define disturbances. Spatial patterns within each disturbance polygon were calculated using vegetation data derived from Landsat TM images. ANOVA was used to determine if disturbance type and time since disturbance significantly affect vegetation pattern indices.)

Ter-Mikaelian, M.T. and W.C. Parker. 2000.
Estimating biomass of white spruce seedlings with vertical photo imagery.
New For. 20: 145-162.
(Photo imagery is a promising non-destructive method for estimating the aboveground biomass of tree seedlings. This method was tested using naturally regenerated white spruce seedlings growing under a mixed conifer shelterwood in central Ontario. Seedlings were sampled from plots exposed to mechanical release treatments applied in early spring and mid-summer and compared with seedlings from unreleased plots. Seedlings were photographed in the field. Then they were harvested and height and basal diameter were measured, and biomass of foliage, branches, main stem, and total aboveground plant tissue determined. Regression analysis revealed a strong relationship between both silhouette area and basal diameter, and seedling biomass. The method was tested by validating the biomass equations using an independent data set from white spruce seedlings from the same site but exposed to different treatments and microsite conditions. The results suggest that photo imagery can be used as an alternative to more traditional allometric methods of biomass estimation and general equations derived from either method are preferable to those specifically calibrated for a given growing environment.)

(Thevathasan, N.V.), (P.E. Reynolds), (R. Kuessner) and F.W. Bell. 2000.
Effects of controlled weed densities and soil types on soil nitrate accumulation, spruce growth, and weed growth.
For. Ecol. Manage. 133: 135-144.
(Soil nitrate accumulation rates were assessed among 7 weed species grown in small plots during the summer of 1997, at a northern Ontario location. Objectives were (1) to quantify soil nitrate accumulation rates at varying weed densities established on 3 soil types (clay, loam, and sand), and (2) to assess the effects of soil nitrate levels on weed and black spruce seedling growth. Controlled densities of red raspberry, fireweed, and a grass species were planted along with spruce seedlings early in the summer of 1994. Concurrently, 4 more deciduous weed species, trembling aspen, white birch, green alder, and willow, were also established at

4 densities. In July 1997, soil samples collected from the respective weed densities were placed in polyethylene bags and the bags incubated in the respective plots for 34 days at a depth of 12 cm. Nitrate accumulation rates, weed heights, and the effective leaf area index of competing vegetation were consistently higher for clay soil. Nitrate levels were significantly higher in clay soil obtained from plots planted with raspberry, grass, aspen, and willow. Carbon:nitrogen ratios were higher for loam soils. These higher ratios may have resulted in more immobilization than mineralization of soil nitrogen. Nitrate levels for clays and loams correlated significantly with the LAI of competing vegetation and with weed growth, but non-significantly, and often negatively, with spruce stem volume. To date, soil nitrate accumulation appears to have primarily benefitted cultivated weeds and not to have improved spruce growth. These findings affirm that weeds must be controlled for seedlings to benefit nutritionally.)

(Treitz, P.M.), P.H. Sampson and (V. Thomas). 2000.
Remote sensing of forest structure and function.
In Can. Assoc. Geographers 200th Ann. Gen. Mtg. Brock University, 31 May - 3 June 2000. Can. Assoc. Geogr.
(Remote sensing research of forests has been conducted using (i) a variety of sensor technologies; (ii) data collected at a range of spatial and temporal scales, and (iii) varied methodologies. The first objective of this paper is to summarize the different requirements for characterizing (i) forest structural; and (ii) forest functional parameters. Secondly, examples from deciduous and coniferous forest environments across northern Ontario will be used to illustrate the importance of scale in examining structural and functional aspects of forest ecosystems. For example, gross variations in reflectance arising from the structural aspects of forests at high spatial resolutions may mask the functional aspects of interest to the forest ecologist/biologist. Gaining an understanding of the relationship between spatial scale (i.e., resolution) and structural and functional parameters is a precursor to how spectral reflectance information can be collected, processed, and analyzed. Once an appropriate scale is uncovered, the relationship of canopy reflectance to leaf-based functional (e.g., nutrient and pigment concentrations) and structural features (e.g., crown cover and biomass) will be explored. Data acquisition and analysis models that address the requirements for structural analysis of forests as well as their functional character will be presented.)

Weaver, K., D. Baldwin, D. Schroeder and A. Perera. 2000.
Quantification of landscape pattern index behaviour for forest management planning.
In GIS 2000. Toronto, ON, 13-16 March 2000. Geo Tech Media, CD-ROM, 9 p.
(GIS-based methods were developed to quantify and visualize the behaviour and spatial context of landscape pattern indices using actual land cover data. Parameters of the analyses were isolated to examine the behaviour of a suite of landscape indices given changes in extent, resolution, and number of land cover classes. The methods developed proved effective for this type of analysis over large extents, especially those used to map and visualize the spatial patterns of index behaviour. Examples of results derived from the various methods are presented and future work outlined.)

(Whitney, R.D.) 2000.
Forest management guide for Tomentosus root disease.
Ont. Min. Nat. Resour., Sault Ste. Marie, ON. Sci. Devel. Transf., 20 p. (Tumble).
(This management guide presents information about identifying, understanding, and managing Tomentosus root rot. Included are descriptions of the disease, related damage, tree species and sites affected, geographic range, as well as disease management strategies. The guide expresses, through photographs, decision keys, and life cycle diagrams, the nature of the disease in the field and silvicultural activities that reduce damage from the disease.)

(Woods, M.E.) and W.T. Zakrzewski. 2000.
Timber product volume tables for jack pine and red pine in Ontario.
Ont. Min. Nat. Resour., North Bay, ON., Southcentral Sci. Sect. Tech. Note No. 05. 9 p. + append.
(Timber product volume tables were produced for jack

pine and red pine using an individual-tree stem profile equation calibrated with Ontario data. The model describes inside-bark diameters along a tree stem and provides a volume estimate for any user-defined section of the tree. The required input is an outside-bark tree diameter at breast height (DBH) and a total tree height (H). Tables of volume estimates by multiple upper diameter limits and pole specifications are provided in the appendices.)

Yemshanov, D.G. and A. Perera. 2000.
Use of geospatial data in developing a Markovian model of vegetation dynamics.
In GIS 2000. Toronto, ON, 13-16 March 2000. GeoTech Media, CD-ROM, 9 p.
(We proposed a probabilistic model of vegetation dynamics and used geospatial data to evaluate the effects of post-disturbance transition of the boreal forest biome. This model uses the transition matrix approach. The dynamics of spatially explicit landscape elements are projected by probability measures. GIS-based forest resource inventory (FRI) data will be used to validate the model by comparing simulated raster mosaics with the existing multitemporal landscape mosaics produced from the FRI database.)

(Zarco-Tejada, P.J.), (J.R. Miller), G.H. Mohammed and T.L. Noland. 2000.
Chlorophyll fluorescence effects on vegetation apparent reflectance: I. Leaf-level measurements and model simulation.
Remote Sens. Environ. 74(3): 582-595.
(Results from a series of laboratory measurements of spectral reflectance and transmittance of individual leaves and from a modelling study are presented which demonstrate that effects of natural chlorophyll fluorescence are observable in the red edge spectral region. Measurements made with a Li-Cor Model 1800 integrating sphere apparatus coupled to an Ocean Optics Model ST1000 fibre spectrometer in which the same leaves are illuminated alternately with and without fluorescence-exciting radiation to separate the fluorescence emission component from the reflectance spectrum. The resulting difference spectrum is shown experimentally to be consistent with a fluorescence signature imposed on the inherent leaf reflectance signature. A study of the diurnal change in leaf reflectance spectra, combined with fluorescence measurements with the PAM-2000 fluorometer, show that the difference spectra are consistent with observed diurnal changes in steady-state fluorescence. The expected effects of chlorophyll fluorescence emission on the apparent spectral reflectance from a single leaf are also simulated theoretically using the doubling radiative transfer method. These modelling results demonstrate that the laboratory observations of a difference spectrum with a broad peak at about 750 nm and a much smaller peak near 690 nm are in agreement with theory. Model simulation shows that chlorophyll pigment and fluorescence each affect indices that are being used in optical remote sensing to characterize pigment levels and stress in vegetation canopies.)

(Zarco-Tejada, P.J.), (J.R. Miller), G.H. Mohammed, T.L. Noland and P.H. Sampson. 2000.
Chlorophyll fluorescence effects on vegetation apparent reflectance: II. Laboratory and airborne canopy-level measurements with hyperspectral data.
Remote Sens. Environ. 74(3): 596-608.
(Relationships found between Compact Airborne Spectrographic Imager (CASI) hyperspectral canopy reflectance measurements at laboratory and field levels with PAM-2000 chlorophyll fluorescence data are presented. This is a continuation of the paper where relationships at the leaf level between leaf reflectance and chlorophyll fluorescence were found and demonstrated to be consistent with theory using the fluorescence-reflectance-transmittance model. Experiments using the hyperspectral CASI sensor in the laboratory to observe a canopy of maple seedlings are performed as an intermediate step to demonstrate the link between the results at leaf level and the CASI field canopy levels. Based on scene observations of the seedlings using a long-pass blocking filter, apparent canopy reflectance in the laboratory is affected by changes in fluorescence

emissions. A laboratory experiment on seedlings subjected to diurnally induced change shows the strong link between CASI canopy reflectance optical indices and dark-adapted chlorophyll fluorescence. Stressed and healthy maple seedlings are used to demonstrate the use of optical indices calculated from the 680-690 nm spectral region to track changes in steady-state fluorescence. To test these findings in a field setting, airborne field hyperspectral CASI data were collected over 12 sugar maple sites in the Algoma region of Ontario in 1997 and 1998. A field sampling campaign was carried out for biochemical contents of leaf chlorophyll and carotenoids, chlorophyll fluorescence, and leaf reflectance and transmittance. Consistency among leaf, laboratory, and field canopy hyperspectral data is shown in this and the previous paper, demonstrating the effect of fluorescence on observations of apparent vegetation reflectance.)

(Zarco-Tejada, P.J.), (J.R. Miller), G.H. Mohammed, T.L. Noland and P.H. Sampson. 2000.
Estimation of chlorophyll fluorescence under natural illumination from hyperspectral data.
Second EARSeL Workshop on Imaging Spectroscopy — From Air to Space: Imaging Spectroscopy for All. Enschede, NL, 11-13 July 2000. EARSel, 6 p. (This paper reports a series of laboratory and field measurements of spectral reflectance under artificial and natural light conditions, which demonstrate that effects of natural chlorophyll fluorescence are observable in the reflectance red edge spectral region. This study was carried out on 12 sites of *Acer saccharum* in the Algoma region of Ontario, where field measurements, laboratory simulation experiments, and hyperspectral CASI imagery have been carried out in 1997, 1998, 1999, and 2000. A study of the diurnal change in leaf reflectance spectra, combined with fluorescence measurements with the PAM-2000 fluorometer, show that the difference spectra are consistent with observed diurnal changes in steady-state fluorescence. Small canopies of *Acer saccharum* have been used for laboratory measurements with the CASI hyperspectral sensor, and under natural light conditions with a fibre spectrometer in diurnal trials in which the variation of measured reflectance is shown experimentally to be consistent with a fluorescence signature imposed on the inherent leaf reflectance signature. Reflectance changes are measurable under natural illumination conditions, although airborne experiments with the CASI hyperspectral sensor produced promising but less convincing results in 2 diurnal experiments carried out in 1999 and 2000, where small variations in reflectance due to the effect of chlorophyll fluorescence were observed.)

(Zarco-Tejada, P.J.), (J.R. Miller), G.H. Mohammed, T.L. Noland and P.H. Sampson. 2000.
Optical indices as bioindicators of forest condition from hyperspectral CASI data.
Pp. 517-522 *in* 19th Symp. European Assoc. Remote Sensing Lab. (EARSeL). Casanora, E., ed. Valladolid, Spain, 31 May - 2 June 1999.
(This paper reports on progress made to link physiologically based indicators to optical indices scaling up from leaf level to the canopy through SAIL and Kuusk canopy reflectance (CR) models. Hyperspectral CASI data of 2-m spatial resolution, 7.5-nm spatial resolution, and 72 channels were collected in 1997 and 1998 over 12 sugar maple sites in the Algoma Region of Ontario. Field sampling was carried out for biochemical analysis of leaf chlorophyll and carotenoid concentrations, and fluorescence along with leaf reflectance and transmittance. Leaf-level relationships obtained between optical indices and biochemical indicators were scaled up to canopy level through CR models using input parameters related to the canopy structure and viewing geometry at the time of data acquisition. The result is an algorithm that predicts leaf-level bioindicators from airborne hyperspectral imagery. Nominal CR model parameters appear to be sufficient to allow accurate application of the optical index/bioindicator algorithm to airborne data.)

Appendix I. Author Index

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Appendix III. Forest Research Reports

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Appendix IV. Forest Research Information Papers

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Appendix V. Forest Research Notes

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Appendix VI. Science and Development Transfer Series

001 MacDonald, G. B., (J. Fraser) and (P. Gray). (eds.). 1999. Adaptive management forum: Linking management and science to achieve ecological sustainability. Ont. Min. Nat. Resour., Sci. Devel. Transf. Ser. No. 001. 58 p.

002 Hayden, J., (E. Boysen), (M. Woods) and J. Rice. 1999. Making cents out of forest inventories: A guide for small woodlot owners. Ont. Min. Nat. Resour., Sault Ste. Marie, ON., Sci. Devel. Transf. Ser. No. 002. 32 p. + append.

003 Bell, F. W., (D.G. Pitt), (M. Irvine), W.C. Parker, L.J. Buse, (N. Stocker), (W.D. Towill), (H. Chen), (F. Pinto), (K. Brown), D. DeYoe, (T. McDonough), (G. Smith) and (M. Weber). 2000. Intensive forest management in Ontario: Summary of a 1999 science workshop. Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sci. Devel. Transf. Ser. No. 003. 86 p.

Appendix VII. Forest Fragmentation and Biodiversity Project Reports

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2 (Carleton, T.J.) and (A.M. Gordon). 1992. Understanding old-growth red and white pine dominated forests in Ontario. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Landscape Ecol. Program: For. Fragment. Biodiv. Proj. Rep. No. 2. 81 p.

2A (Carleton, T.J.) and (A.M. Gordon). 1992. Understanding old-growth red and white pine dominated forests in Ontario. Appendices. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Landscape Ecol. Program: For. Fragment. Biodiv. Proj. Rep. No. 2A. 215 p.

3 (Welsh, D.A.), (T.P. Clark) and (K. Clark). 1992. Fauna of red and white pine old-growth forests in Ontario: Issues and recommendations for research. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Landscape Ecol. Program: For. Fragment. Biodiv. Proj. Rep. No. 3. 56 p.

4 (Haider, W.) 1992. Scenic beauty and other values of red and white pine old-growth forests. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Landscape Ecol. Program: For. Fragment. Biodiv. Proj. Rep. No. 4. 145 p.

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7 (Band, L.E.) 1993. A pilot landscape ecological model for forests in central Ontario. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Landscape Ecol. Program: For. Fragment. Biodiv. Proj. Rep. No. 7. 40 p.

8 (Kershaw, H.M.) 1993. Early successional processes of eastern white pine and red pine in the Great Lakes-St. Lawrence forest: A literature review. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Landscape Ecol. Program: For. Fragment. Biodiv. Proj. Rep. No. 8. 50 p.

9 Perera, A.H. and D.J.B. Baldwin. 1993. Spatial characteristics of eastern white pine and red pine forests in Ontario. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Landscape Ecol. Program: For. Fragment. Biodiv. Proj. Rep. No. 9. 82 p. + append.

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18 (Clark, T.P.) and A.H. Perera. 1995. An overview of the ecology of red and white pine old-growth forests in Ontario. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Landscape Ecol. Program: For. Fragment. Biodiv. Proj. Rep. No. 18. 29 p.

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23 (McLaughlin, C.G.) 1998. Habitat allometry: Evaluating changes in species richness using species-area models. Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Landscape Ecol. Program: For. Fragment. Biodiv. Proj. Rep. No. 23. 28 p.

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Appendix VIII. Contact Information for Other Publication Sources

CFS - Canadian Forestry Service
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1219 Queen St. E.
Sault Ste. Marie, ON P6A 2E5
Phone: (705)-759-9461 ask for publications
Website: http://www.glfc.cfs.nrcan.gc.ca

Forest Science Coop
777 Red River Rd
Thunder Bay ON P7B 1J9
Phone: (807) 346-2860

NRIC - Natural Resource Information Centre
Ontario Ministry of Natural Resources
4th Floor, South Tower,
300 Water Street, P.O. Box 7000
Peterborough, ONK9J 8M5
Phone: 1-800-667-1940

NESI - Northeast Science and Information
Ontario Government Complex
Hwy. 101 E., P.O. Bag 3020
South Porcupine, ON P0N 1H0
Phone: (705) 235-1157

SCSI - Southcentral Science and Information
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